THE

JOURNAL

OF

ZOOLOGICAL RESEARCH.

EDITED BY

WALTER E. COLLINGE, D.Sc. (St. And.), M.Sc. (Birm.),

F.L.S., F.E.S.,

Research Fellow of the University of St. Andrews;
Foreign Member of the American Association of Economic Entomologists;
Honorary Fellow of the Royal Horticultural Society; late
Lecturer in Zoology and Comparative Anatomy
in the University of Birmingham.

1916.

LONDON:

DULAU & CO., LIMITED,

37, Soho Square, W.

1916.

CONTENTS.

No. 1 (APRIL, 1916).

No 2 (JUNE, 1916).

No. 3 (SEPTEMBER, 1916).

No. 4 (DECEMBER, 1916).

THE

JOURNAL OF ZOOLOGICAL RESEARCH.

NOTE ON THE GENUS *JASMINEIRA*, LANGERHANS.

By PROFESSOR W. C. M'INTOSH, M.D., LL.D., F.R.S.,

The Gatty Marine Laboratory, St. Andrews University.

THIS genus was instituted by Langerhans[1] in 1880 for a minute Sabellid found at Madeira, and was thus characterized :—Sabellids having a uniserial series of long crotchets in the anterior (thoracic) region, whilst posteriorly they possess short or avicular uncini as in the ordinary Sabellids.

He thought that the genus stood near Claparède's genus *Dialychone*, though in the latter the posterior hooks are Terebelliform, whilst in *Jasmineira* they are Sabelliform. The new genus, along with *Bispira, Dasychone* and *Laonome*, would hold an intermediate position between the Sabellids (*Spirographis, Branckiomma, Potamilla* and *Sabella*) and the Chonids (*Euchone, Chone, Dialychone, Oria, Fabricia, Leptochone* and *Myxicola*). His only species was *J. caudata*, measuring 0.5 cm., with 7 branchial filaments, connected by a web on each side, green blood, a pair of oblong, reddish eyes on the first segment, a pair of statocysts in the second, and a rather full collar projecting beyond the basal pillar of the branchiae, and which was split dorsally but entire ventrally.

The anterior bristles were of two kinds, capillary with moderate wings, and what he termed paleae, like those of *Potamilla*, but which may more appropriately be called spatulate bristles. Ventrally the anterior region carries long, slightly curved crotchets, which enlarge from the base to the shoulder, are slightly narrowed at the neck, from which the chief fang comes off nearly at a right angle and has three teeth on the crown above it. The posterior bristles he describes as bayonet-like, viz., with wings and long delicately-tapered tips; whilst the posterior hooks were "Sabelliform," that is, avicular, but his figure indicates a marked divergence from the ordinary Sabellid hook, for the neck is so elongated as almost to resemble a shaft, the main

[1] Zeitsch. f. wiss. Zool., Bd. xxxiv, p. 113, T. v, fig. 32.

fang coming off at less than a right angle and the three teeth on the crown above it in lateral view being distinct. The anal segment has no pigment, but carries a median subulate cirrus with the anus "dorsal."

The body is nearly cylindrical throughout, only a little tapered toward the tail. The anterior (thoracic) region has 9 segments, the posterior 17 segments.

The differences pointed out by the author between *Jasmineira* and the other Sabellids, especially the Chonids, are by no means striking, every character he mentions, except the caudal cirrus, being met with in other forms. Yet there is one essential distinction between it and the ordinary Sabellids which appears to have escaped him, viz., the remarkable elongation of the posterior hooks, which seems to be a stable character of the group. Moreover, a tendency to a globular or mushroom-shaped base for the branchiae appears to be general, and this in certain of the larger representatives, such as *Chone reayi* and *C. princei*, often projects considerably beyond the collar after removal of the branchiae.

Langerhans[1] in a later paper on the Polychaet Fauna of Madeira contributes two additional species to the genus. One of these, *Jasmineira candela*, had originally been described by Grube[2] from Adria, though not in this connection. It measures 1.5 cm. with the branchiae, and the body is tinted with reddish specks. The branchiae were 16, and remarkable for the wing-like oval tips to the filaments. The ventral border of the collar had a median and two lateral notches. The anterior region was composed of 8 segments, and the bristles conformed to the structure of the type, both narrow winged and spatulate forms being present, whilst posteriorly the usual elongation of the tips occur. The anterior long hooks or crotchets have curved shafts, and the main fang leaves the neck, which appears from the figure to have no shoulder, at less than a right angle, and has five smaller teeth on the crown. The posterior hooks are "Sabellid," but are not figured. The anal segment is bluntly conical, with lateral groups of pigment-specks.

Further, the author describes *Jasmineira oculata*, a new form, 0.5 cm. long, and colourless, with 10 branchial filaments without a connecting membrane. The dorsal collar is split, and on either side of the cephalic region is a group of eyes. The first bristled segment has a pair of statocysts with round statoliths. Eight segments occur

---

[1] Zeitsch. f. wiss. Zool., Bd. xl, p. 270, pl. xvi, figs. 33 and 34.
[2] Arch. fur Naturges, 1863, p. 60.

in the anterior region with the characteristc bristles, the spatulate forms of which appear to have somewhat narrower wings than in *J. candela,* Grube. The anterior hooks have curved shafts, a main fang which comes off nearly at a right angle and with six small, but prominent teeth on the crown above it, whilst a distinct shoulder is present below the somewhat long neck. The posterior region has bristles with attenuate tips, and long-necked circular hooks. Two eyes occur on the anal segment.

De St. Joseph[1] next procured a species, *Jasmineira elegans,* abundantly in the dredged material off Dinard, France, a form which has since been found frequently at Plymouth (Allen), Torbay and elsewhere (Elwes), as well as the West Coast of Ireland (Southern). This form reaches about 18 mm., including the branchiae, and a description from British specimens was lately given in the *Annals of Natural History* for January.

The genus, however, has still further been extended by two large forms, also described in the communication just mentioned, one of which is British and the other Canadian. In the British species (*Chone reayi*) there are no less than 55 segments, whilst in *C. princei* there are about 60. In both the bases of the branchial fans, after removal of branchiae, project beyond the collar, and have a mushroom-like appearance. In both the typical Jasmineiroid posterior hooks are present; yet in certain other characters they bridge the gap between *Jasmineira* and *Chone,* so that the distinctions at first supposed to be diagnostic are toned down and a few new features added. Thus the posterior hooks are carried a stage further than in the previous forms (*Jasmineira* of Langerhans), the long neck merging below into a curved tapering basal region, which approaches that of an anterior crotchet, yet the small teeth on the crown above the main fang are specially distinct as in *Jasmineira.*

[1] Ann. Sc. Nat. 7e ser., t. xvii, p. 316, pl. xii, figs. 337-346.

ON THE LIFE-HISTORY AND STRUCTURE OF *TELEPHORUS LITURATUS*, FALLEN. [COLEOPTERA].

By OLGA G. M. PAYNE, M.Sc.,

Late Research Assistant in the Department of Agricultural Entomology of the University of Manchester.

WITH PLATES I AND II AND 18 TEXT-FIGURES.

CONTENTS.

I.—INTRODUCTION.

DURING the years 1911 and 1912 a number of *Telephorus* larvae were obtained from a field, near the Entomological Laboratory of the Manchester University, at Fallowfield. The adults were bred out from

these, and numerous observations were made on the anatomy of the larva and the general life-history of the species. The results of this work are embodied in the present paper.

I should like to take this opportunity of thanking Professor Sydney J. Hickson for very kindly allowing me to work in the laboratories of the Manchester University, also Mr. J. Mangan and Dr. A. D. Imms, of the Manchester University, who have been most kind in helping me.

II.—Larval Life and Habits.

a. Habitat.—Larvae of *Telephorus lituratus* were obtained from a field adjoining the University Entomological Laboratory at Fallowfield, near Manchester. They were largely taken from a strip of ground about 50 yards long and 2 feet broad, bounded by a wall which touched upon the main road, and was therefore planted with a number of trees, chiefly birch, with some elders and rhododendrons. It was separated from the open field by a moss-covered path. The larvae were usually to be found among and below the grass roots, at a depth of about two inches; they were more abundant near the roots of the trees, especially those of the rhododendrons and elders. The reason for this was probably that the foliage of these plants was near the ground, and kept the soil beneath them moister than that beneath the birches, where there was no low foliage, this especially applies to the rhododendrons, which are evergreen.

Occasionally the larvae were taken from other parts of the field, and occasionally from a rubbish heap near by.

In cold weather they were always to be found curled up in the soil, but on sunny days they were to be seen creeping along the mossy path. Westwood (24) has noted this habit in the case of other Telephorid larvae.

In walking, the head and first thoracic segment are moved from side to side, and the abdomen is drawn after by a rippling series of muscular contractions, aided by the abdominal proleg. The movements are slow compared with those of a Staphylinid or Carabid larva. The dark, velvety covering of Telephorid larvae makes it at first very difficult to distinguish them from the soil, but when this is overcome they may easily be obtained by pulling up and shaking the grass roots.

The first larva was found in October, and was very well grown, measuring 18 mm. in length. During November, twelve specimens were obtained, varying in length from 12-18 mm.; in December, sixteen specimens were obtained, lengths from 13-17 mm. During January, twenty larvae were found, varying from 15-19 mm. in length,

and in February twenty-one larvae, with lengths from 15-18 mm.; and again in March, thirteen larvae, with lengths 15-18 mm. In May and June four larvae were found, with lengths from 15-20 mm. On May 12th the first pupa was taken, and on June 1st the first adult was found in the open. Eggs were laid by adults captured on June 24th, on the following day. The eggs are small and yellow, and measure .5 mm. in diameter. They did not hatch out. These dates differ slightly from those given by Waterhouse (23), who speaks of pupation in April and emergence in May. During the latter part of July no adults were to be found. The total number of larvae taken was eighty-seven.

b. Habits of the Larva.—The number of larvae obtained rendered rearing possible, and accordingly the majority were put singly in small breeding tins, in a greenhouse reserved for the purpose. The temperature of this greenhouse, except on very hot days, rarely exceeded normal room temperature. A number of the larvae were also placed in captivity in the open as controls, and in order to keep the conditions as near the normal as possible, several were put together in glass dishes, which gave room for a larger quantity of soil.

c. Food.—It is usually stated that the larva of *Telephorus* is carnivorous, but it seems more likely that it should be considered as omnivorous.

The first larvae taken were fed upon small earthworms (*Lumbricus terrestris*), and during the first two days of captivity these were partaken of freely by the larvae, and a whitened-looking skin was left as though the inside had been sucked out. After several days of captivity the larvae would not touch the worms. Raw beef was sucked in a manner similar to that in which the worms had been taken, the whitish muscle fibres being left. In order to determine the true food of the larva in the free state several experiments were made. A number of larvae captured at the same time were given separately as food, representatives of the various likely living inhabitants from the soil from which they were taken, with the following results:—

Slugs, though repeatedly given, were never touched, and only on one occasion a very small slug, which had previously been partially mutilated, was attacked. The slug defended itself by exuding a quantity of slime, which clogged up, and for a time completely disabled the mandibles of the Telephorid larva.

Actively moving animals, such as small Carabid larvae, centipedes and millipedes, were never touched. Probably they were too active for the more slowly moving Telephorid larva.

The larvae of a Syrphid, *Platycheirus albumanus* (Fab.), were found in large numbers hibernating in the soil. These, when given

to the Telephorus larvae, were devoured readily. Usually a larva seized the Syrphid larva with its mandibles in the middle of the body, and maintained its hold despite all resistance, until the latter had ceased to struggle. The contents of the body were then sucked out and the empty skin was left. The Telephorid larvae also devoured with great readiness a number of Noctuid larvae of the genus *Leucania*.

It has several times been stated in literature, that the food of the Telephorid larvae consists largely of small snails, but experiments with these did not give the looked for results. Only one snail, which had a broken shell, having at all the appearance of having been attacked.

Small dipterous larvae of the family Borboridae were in several cases taken, in a manner similar to that in which the Syrphid larvae had been taken.

Similar experiments with regard to feeding habits were made with those larvae kept in captivity in the open, and similar results were obtained to those given above.

Other experiments were undertaken with regard to vegetable food, but pieces of potato, turnip, carrot and celery were readily devoured; the vegetables themselves presented a gnawed appearance, and in several cases gnawings were scattered on the soil round about. Other larvae were given similar vegetable food, which in this case was not cut; the outer-skins were never found to have been penetrated by the Telephorid larvae. It is probable therefore that though the larvae might, under natural conditions, devour vegetables in the soil, they would not be those in a sound condition, but rather those in a diseased state, or which had already been penetrated by other animals. They would not themselves instigate the attack.

Remer (17) speaks of the larvae of *Telephorus fuscus* as attacking wheat in a field near Breslau, and from his own experiments he proved this to be the case. Ormerod (13) also mentions wheat being attacked near Faversham by Telephorid larvae, thought to be *Telephorus rufus*. Similar experiments performed towards the end of February with *T. lituratus*, gave very definite results with regard to this. Fresh specimens of the larvae were given wheat, oats, barley, and Indian corn, soaked and unsoaked. Both soaked and unsoaked wheat grains were found to be readily devoured, the grains being always eaten at the germinating end, which is softer. In only a few cases were the barley and oat grains attacked, the husks appearing to act as a protection. In only one case was the Indian corn attacked. In the case of the wheat the young shoots as well as the grains were eaten. There were also indications that the roots of the other cereals given had been gnawed, although it was very difficult to determine this accurately.

The large amount of damage which these larvae are capable of doing may be realized by the following figures:—

In little more than a month one hundred and eighteen wheat grains were eaten by twenty-five larvae. One larva, in a night, would devour almost a whole grain, with the exception of the outer skin, and where the grains were supplied in abundance, eight larvae were found in one night to have destroyed as many as thirty wheat grains. Wheat grains were obviously preferred to any other food, as both Syrphid and Noctuid larvae were discarded if given at the same time. Peas and beans were never touched; perhaps their nitrogenous composition may account for this. In all cases the vegetables and cereals were given to the larvae during months when, if the latter had been in the free state, they could have found such things in the soil. As a rule, food was always taken at night.

Before performing different experiments it was necessary that the larvae should have been freshly taken, as larvae kept in captivity, though taking food at first, usually refused after a short time to eat anything.

In connection with the feeding habits of the Telephorid larvae, a curious habit of those kept in captivity may here be noted. At the top of the soil in the breeding tins small pieces of moss were usually placed in order to keep the soil moist. These were found to have been bored into continually by the larvae. Often on moving a piece of moss aside, the larva would be found with its head buried in the soil on which the moss was growing. Later it was found that pieces of moss which had been kept away from the larvae were covered with a number of young seedlings, while those in the tins did not produce any. It may be possible that the larvae were burrowing into the soil of the moss in search of the seeds.

Summing up the above facts, it seems likely that the Telephorid larvae are, as is usually stated, primarily carnivorous, for in the soil in which they were found there seemed to be very little vegetable food. Whether, however, they can be considered as beneficial remains doubtful, considering that in the case of *T. lituratus* the larva of *Platycheirus* in all probability forms part of their food supply. The latter larva has been found by Cameron (2) to prey upon a species of Aphis—*Pterocallis tiliae,* infesting lime trees. It is quite likely that in the case of other Telephorid larvae, differently situated, other hibernating larvae would be discovered. Ormerod (13) mentions Telephorid larvae as preying upon the maggots of the Plum Weevil. In connection with this, Dr. J. B. Smith says that the larvae are especially effective against such creatures as the larvae of the Plum

Curculio, when they enter the ground to pupate, and a large proportion are thus disposed of annually. This supports what has already been shown, that any small, soft and sufficiently inactive larva would in all probability be devoured by the Telephorid larvae. On the other hand, it seems probable that in the absence of a sufficient supply of animal food, and given the proximity of cereals or vegetables, they would readily do serious damage. Ormerod notes that in the case of the larvae found attacking wheat near Faversham, the wheat had been planted after clover, and she considers it possible that the larvae had primarily been feeding upon the maggots of the clover leaf weevil.

Riley considers that the larva of *Telephorus* (?) *bilineatus* should probably be considered as a beneficial insect. He has found it feeding upon the larvae of the codling moth (*Carpocapsa pomonella*), and has frequently met it among young windfalls, under apple trees, and upon the fruit on the trees, where it was probably looking for the larvae in the infested fruit.

d. Enemies.—In no case have the larvae of *T. literatus* been found to attack each other. As many as fifteen have been enclosed in a small tin, and have all been taken out unharmed. De Geer mentions in the case of *T. fuscus* that the larvae do prey on each other. The larvae of *T. lituratus* were found to be readily attacked by a member of the family Carabidae—*Pterostichus madidus*, both in the larval and pupal state. On being annoyed the larvae usually shoot out a quantity of blackish liquid from the mouth; this fluid appears to be stored in the alimentary canal (see p. 18). Owing to their hairy covering they can survive the effects of water for a long time. The dishes of those kept outside were several times swamped by heavy rains, but the larvae were always to be found perfectly dry, coiled up in the mud. The absence of moisture does not seem so directly fatal to them compared with other species having a more delicate integument. A total absence of moisture effected the death of a Carabid larva in one night, while a Telephorid larva under similar conditions was found to exist for two days.

e. Ecdysis and Growth.—Cast skins of the larvae were never to be found except after pupation, when the skin is shed, and is usually to be found attached to the end of the abdomen of the pupa. It is therefore impossible to show by the number of moults that the larvae increase in size. As the skin is very soft and elastic it is possible that the number of moults may not be many. The difficulty, however, remains that the size of the larval head varies considerably. Taking at random the following lengths of preserved specimens, the following measurements were obtained :—

Specimen A	Length 11 mm.	Width of head	=	1·1 mm.
		Length ,,	=	1·2 ,,
Specimen B	,, 17 ,,	Width ,,	=	1·5 ,,
		Length ,,	=	1·6 ,,
Specimen C	,, 20·1 ,,	Width ,,	=	1·9 ,,
		Length ,,	=	2·0 ,,

Specimen A of 11 mm. represents the smallest which was obtained, but many measurements of larvae of lengths varying from 12—14 mm. show the head to vary from 1.0—1.2 mm. in width. All the heads which were taken from cast larval skins on pupation were measured, and none were found to measure less than 1.5 mm. in width. It therefore follows that growth of the head must at some time have taken place. It seems also probable that the mature size, as regards the head, is reached at an early stage in the life-history, and that subsequent feeding merely serves to increase the fatty contents of the body preparatory to pupation.

III.—Pupation.

Both in the open and in captivity, where there was sufficient soil, the larvae, before pupation, formed small, circular burrows, in which they remained for some time, curled up. After the formation of the burrows the larvae ceased to feed. In the open field these burrows were found to be formed at a depth of 2—3 inches in the soil, and especially in damp parts where clay was present: the moist, adhesive nature of this soil probably forming a protection against evaporation for the very delicate pupae. In captivity, though the burrows were made, the larvae never pupated in them, though always in the open they were found to be so concealed. The first larva, in captivity, pupated about the end of March, and all pupations inside the greenhouse were completed before those outside had begun.

The dates of pupation of those kept outside in captivity, and those found free in the field coincided. The pupae were found to be very difficult to bring to the adult condition. They were repeatedly attacked by fungus, and any increase in temperature above normal room temperature caused them to emerge too soon, in which case they were not properly developed. Too much heat caused them to become quite black and die. The importance of the clay soil in which they would normally pupate is here shown again. They were found to do best when kept in the dark in the laboratory, and not in the greenhouse, and the best-formed adults were obtained from pupae kept in the laboratory in zinc boxes with perforated lids, so that they were always in contact with the fresh air. These boxes are also an advantage, as they do not rust when put out in the open air.

IV.—Adult Life and Habits.

Close observations have not been made upon the habits of the adult *Telephorus lituratus*. In the open they were found upon nettles, and on grass and trees above their larval habitat.

As before mentioned, the eggs in one case were found to be laid towards the end of June. At the end of July the adults could no longer be found, and it may therefore be concluded that egg-laying takes place during those two months; it may also be inferred that adult life does not last much longer than six weeks. Adding to this the average two weeks of the pupal period, and subtracting from the total months of the year, the remaining ten months may be considered as the duration of the embryonic and post embryonic life. Of these the embryonic life is as yet an unknown factor; obviously, however, it cannot last long, as fully grown larvae, as has before been mentioned, were found in October. From observations of other species of *Telephorus*, it seems that the adult as well as the larva may be considered as omnivorous. Experiments with a species closely resembling *T. lituratus* showed that aphides were devoured if imprisoned with the beetle. The species of Aphis was one infecting the Elder. In *Insect Life*, vol. ii, there is an interesting article by Coquillett, who has observed a species of *Telephorus* feeding upon the eggs of *Icerya*, which was infesting a cedar of Lebanon.

Packard (14) states that the adult of *Telephorus* (?) *bilineatus* feeds upon the newly expanded leaves of the birch; also that "the perfect insect appears to be mainly a vegetable feeder, having been shaken from the branches of plum, peach and apricot trees." Taschenburg (22) also remarks upon a species of *Telephorus* devouring young oak leaves. Westwood, and De Geer refer to the canniballistic habits of the adult Telephorides. *T. bilineatus* appears to be an exception to most allied species in this respect, as when several adults were accidentally enclosed togther, they did not do each other any harm.

Popenoe and Smith (16) note an attack of fungus disease on a species of an allied genus, *Chauliognathus pennsylvanicus* (De G.). The fungus attacked and distended the abdomen, and produced white, green, and grey rings of dense mycelial growth on the thin membranous body wall between the segments. Four genera of fungi were found to be present, viz., *Cladosporium*, *Macrosporium*, *Sporotrichum*, and *Fusarium*, but no one of these three species was present in sufficient quantity to be the probable first cause of the disease. A similar attack was noted on *Chauliognathus marginatus*. They also remark upon the feeding habits of *Chauliognathus*. "In this connection it may be noted that although the various species of *Chauliognathus* feed as

adults almost entirely upon the pollen of flowers, in the early larval stages their food is composed of various soft-bodied insects—largely aphides and other forms living near the ground. The usual abundance of these beetles acts no doubt as a check to the increase of several species of injurious aphides, such as the pea aphis, *Macrosiphum pisi*, Kalt., and the two species mentioned may thus be considered of distinct economic value."

V.—Description of the Mouth Parts of the Adult.

The mouth parts of the adult beetle consist of (1) mandibles, (2) maxillae, and (3) labium.

The mandibles (Fig. 1) are very like those of the larva (p. 14 and Pl. I, figs. 4 and 5), with the exception that the median tooth present in the larval mandibles is absent in those of the adult.

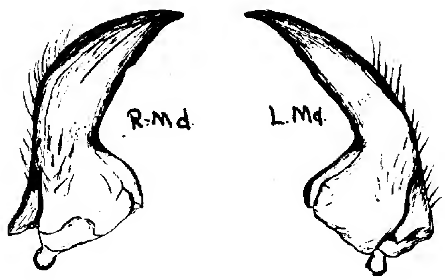


Fig. 1. Adult mandibles. × 54.
R. Md. Right mandible; *L. Md.* Left mandible.

The 1st maxillae (Fig. 2) are well developed, and are attached on each side of the labium. Each consist of a four-jointed palp (*Mx. pl.*) attached to the outer surface of the cardo (*cd.*), which also bears a hooked galea (*ga.*), and on a small lateral projection a bud-shaped lacinea (*la.*). Both galea and lacinea are covered with long bristles. A small chitinous stipes (*st.*) forms the attachment of the maxilla to the labium.

The labium (Fig. 3) is composed of a single median fused lacinea and galea of each side (*la.*), on the inner surface of which a pair of four-jointed palps are borne (*la.* pl.). This is supported on a narrow mentum (*mn.*), with which the stipes of the 1st maxillae articulate. The mentum rests on a still narrower submentum (*sm.*). A small tongue-shaped projection from the inner surface of the anterior end of the mentum appears to represent the hypopharynx of the larva (p. 15 and Pl. I, fig. 9).

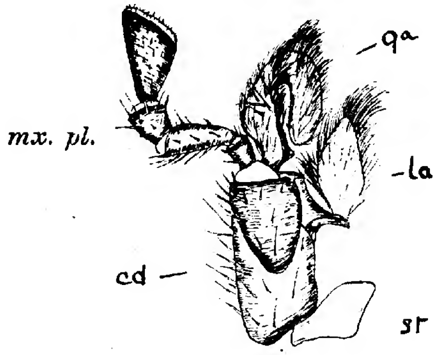


Fig. 2. Right maxilla of Adult. × 54.
cd. Cardo; *ga.* Galea; *la.* Lacinea; *mx. pl.* Maxillary palp; *st.* Stipes.

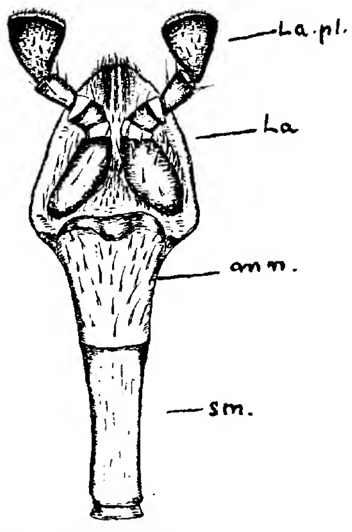


Fig. 3. Labium of Adult. × 54.
La. Labium; *La. pl.* Labial palp; *mn.* Mentum; *sm.* Sub-mentum.

VI.—External Features of the Larva.

Fully grown larvae, extended, measure from 18—21 mm. in length (Pl. I, fig. 1).

Head chitinised, dark brown in colour, flattened dorso-ventrally. Average width 1.65 mm.

Thoracic and abdominal segments soft, varying from reddish-brown to dark brown in colour. These segments present a velvety appearance, due to a close covering of soft hairs; this appearance is lost after immersion in spirit.

Head.—From the dorsal surface (Pl. I, fig. 2) the head is seen to be divided transversely into two regions; the anterior region (*ar.*) is smooth and shiny, with few hairs, and is continued only a short way on to the ventral surface (Pl. I, fig. 3, *ar.*); the posterior region (*pr.*) has the same velvet-like appearance as the body, due to a similar hairy covering: it forms almost the whole of the ventral surface of the head. The anterior part of the head bears in the median line a blunt tooth (Pl. I, fig. 2, *th.*), and the anterior margin is indented, and forms laterally a curved surface for the articulation of the mandible (*a.m.*). A similar point of attachment is represented on the ventral surface (Pl. I, fig. 3, *a.m.*). On each side above the line of juncture of the two head regions is a small, clear ocellus, above which is situated the antenna (Fig. 4). This is composed of two segments. The soft skin covering the tip of the distal segment forms a base for two small chitinised processes (*an. p.*). These structures may be noted in other Telephorid larvae.

Fig. 4. Antenna of Larva. × 54.
an. p. Antennary process.

Mandibles (Pl. I, figs. 4 and 5).—The mandibles are powerful, sharply pointed and unidentate internally. When closed the left is usually ventral to the right, though about 6 per cent. of the larvae examined showed the right ventral to the left. Figs. 4 and 5, Pl. I, show the mandibles from the underside; *gg.* and *gg.*[1] are the two points of articulation with the head capsule.

Maxillae (Pl. I, figs. 3 and 6).—The maxillae and the labium are very simple compared with the adult structures. They are united in what might be termed a maxillo-labium, which is soft and fleshy,

and plays an important part when the insect takes its food, owing to the freedom with which it can be contracted and expanded. This freedom of action is allowed by a loose fold of skin which unites the maxillo-labium to the head, and which is strengthened by two median chitinous processes (*c. p.*), to which muscles are attached.

The maxillae consist of two parts, a four-jointed palp and a single process (*mxl.*), which is the undifferentiated lacinea and galea of the adult. The labium consists of a pair of three-jointed palps, the first joints are united. The fleshy base of the maxillo-labium bears outwardly three chitinous processes (Pl. I, fig 3, *Mx. pl.*), a median and two lateral ones, which represent the only differentiation of the bases of the maxillae and the labium. Inwardly the maxillio-labium bears a chitinous structure (*hyp.*), which appears to be the hypopharynx, and is an important part of the mouth. There is no indication of maxillulae.

Thorax.—The first thoracic segment averages 2.4 mm. in width, and bears dorsally two transversely elongated, diamond-shaped markings on the integument. The second and third thoracic segments are broader, averaging 2.8 mm. in width; they bear obliquely directed, longitudinally elongated diamond-shaped markings. These marks represent thickenings of the integument for muscular attachment. Between the segments there are similar thickenings. Each segment bears ventrally a pair of four-jointed legs (Pl. I, fig. 7, l^1, l^2, l^3, and fig. 8); each terminates in a single claw.

Abdomen.—There are nine abdominal segments, averaging 2.9, 3.1, 3.2, 3.2, 3.1, 2.9, 2.5, 2.1, and 1.5 mm. respectively in width. Each segment is clearly outlined dorsally and ventrally by transverse swellings, which give the arrangement of the segments rather the appearance of a geometric pattern (Pl. I, fig. 1). Each segment has two pairs of whitish marks, an inner and an outer pair, not very clearly defined. The last segment has similar diamond-shaped markings to those on the second and third thoracic segments, which indicate the point of attachment of the longitudinal dorsal muscles. The last segment bears a telum or proleg, which has 4—6 soft, white swellings, which enable the insect to grip and assist in walking. The ventral surface of the larva is paler than the dorsal, especially in the abdominal region. The whole body has a padded appearance, and is very flexible and capable of considerable contraction and expansion. On each segment of the body there is situated on the dorsal surface a pair of pores (Pl. I, figs. 7 and 10, *gl.*), which communicate with subcutaneous glands (see p. 20).

Spiracles (Pl. I, figs. 7 and 10).—There are nine pairs of spiracles,

the first of which are situated on the ventral surface of the second thoracic segment, in front of the second pair of legs (fig. 7, *th. sp.*). The others are situated laterally on the first eight abdominal segments (fig. 10, *sp.*[1], *sp.*[2], *sp.*[3]).

Waterhouse (23) gives a description of the larva of *Telephorus rufus* with figures, but unfortunately they do not give a very clear idea of the larva, and might be used almost for any species of *Telephorus.*

Beling (1) gives a description of *T. rufus*, but as he gives no figures, his article is not of great use for purposes of identification, though his dates of comparison of the pupation of the different species are of interest.

VII.—External Features of the Pupa.

The pupa varies from 7—13 mm. in length, according to the size of the larva on pupation. It is yellow in colour, and of a very soft consistency. The adult features are visible beneath the transparent pupal sheath.

The antennae (Fig. 5, *an.*) lie behind the femora of the first and second legs (*l.*[1], *l.*[2]), and against the elytra (*el.*), which practically cover the wings. The third pair of legs (*l.*[3]) are partially hidden by

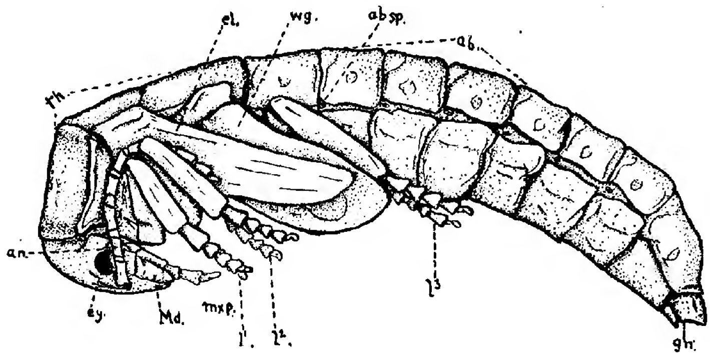


Fig. 5. Pupa. × 11.
ab. Abdomen; *ab. sp.* Abdominal spiracles; *an.* Antenna; *el.* Elytra; *ey.* Eyes; *gn.* Genitalia; *Md.* Mandible; *mx. p.* Maxillary palp; *th.* Thorax; *wg.* Wings; l^1, l^2, l^3, Legs.

the wings. From the side the adult mandibles (*m.*) and maxillary palps (*mxp.*) can be seen.

The thorax and abdomen have the adult segmentation, and the spiracles (*ab. sp.*) are visible between the terga and sterna of the first

seven abdominal segments, the genitalia (*gn.*) protruding from the eighth segment.

VIII.—Anatomy of the Larva.

a. Methods.—The following description of the anatomy of the larva of *Telephorus lituratus* is based upon a number of dissections, for which a Zeiss binocular microscope was used. A number of sections were cut of the alimentary canal, which was found to be very delicate and brittle, and to require very careful handling. The best results were obtained by fixing with Bless' solution. Delafield's Haematoxylin gave the best staining effects. The tracheal system was made out from freshly dissected specimens, in which the tracheae were still filled with air. The nervous system in a freshly opened specimen was found to be too soft for immediate dissection; it was therefore allowed to remain for several days in 70 per cent. spirit. If left for about 12 hours in Perrenys' fluid and then transferred to 70 per cent. spirit for 48 hours, the nerve fibres became very white and were more easily dissected.

b. Alimentary Canal. (Pl. I, figs. 12 and 13).—The alimentary canal (Fig. 6) extends as an almost straight tube from the anterior to the posterior end of the body. The opening of the mouth lies between the labrum and the maxillo-labium, and leads into a small pharyngeal dilatation (*ph.*) of the narrow oesophagus (*oe.*); both are strongly chitinised on the inner surface.

The oesophagus reaches to about the middle of the first thoracic segment, passing below the supra-oesophageal ganglion or brain (Pl. I, fig. 12, *br.*) and then expands into a crop-like enlargement (*cr.*) of the hinder end of the oesophagus; this also is lined with chitin.

The crop reaches just beyond the first thoracic segment, and is always found covered by a closely-lying, whitish, fat body (Pl. I, fig. 12, *fb.*[1]). In young larvae the fat body does not completely cover the crop, but in older specimens it entirely obscures it and extends slightly over the base of the brain. Towards the middle of the second thoracic segment the crop narrows slightly, and then expands into a soft, elongated region (*md.*), which appears to correspond with Packard's (14) mid-intestine or chylific stomach, as there is apparently no internal chitinous lining. Fig. 7 shows a portion of the wall of the mid-intestine in transverse section. The epithelial layer (*E.*) is of a glandular nature, and there is no inner chitinous layer. Outwardly the wall is strengthened by circu'ar (*Mc.*) and longitudinal (*Ml.*) muscle fibres, the boundary of the outer surface being the peritoneal membrane (*Pm.*).

The mid-intestine may be distinguished from the remaining

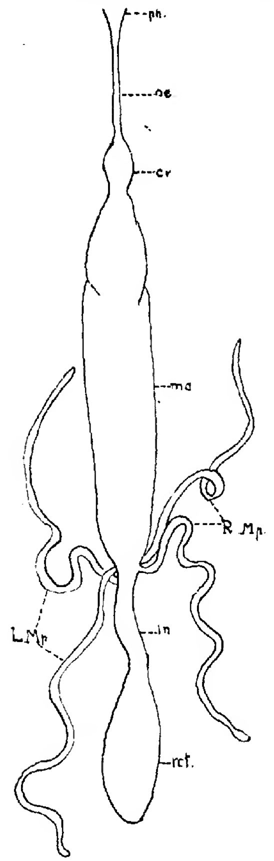


Fig. 6. Alimentary Canal of the Larva. × 10.
cr. Crop; *in.* Intestine; *L. Mp.* Left Malpighian tubules; *oe.* Oesophagus; *ph.* Pharynx; *R. Mp.* Right Malpighian tubules; *md.* Mid-intestine; *rct.* Rectum.

regions of the alimentary canal by the dark pigmentation of its tissues (Pl. I, fig. 12). This appears to be due partly to a dark colouration of the epithelial layer itself, and partly to a blackish fluid which is usually present inside the mid-intestine, and which is probably secreted by the epithelial cells. The black fluid ejected from the mouths of the larvae when they are frightened has been previously mentioned, and it seems highly probable that it is some of the fluid from the mid-

intestine which is forced out on these occasions. This appears to be the only explanation of the dark liquid from the mouth, for there is a total absence of salivary or other glandular structures attached to the alimentary canal. The fluid ejected from the mouth of the larva always appeared to be clear, while that found in the mid-intestine had several times the appearance of being turbid with small solid particles. Thus it may be that the fluid ejected by the larva is in the freshly secreted state, and it is not the actual gut contents which are forced out. The small quantity of the liquid which could be obtained rendered very detailed examination impossible.

The presence of small solid particles in the gut may be explained if the fact is remembered that, besides sucking the juices of other insects, the Telephorid larvae gnawed solid vegetable food, and in the

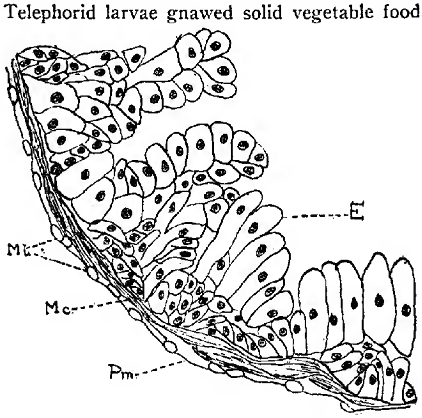


Fig. 7. Transverse section of a portion of the mid-intestine of the Larva. × 140. *E.* Epithelium; *Mc.* Circular muscle fibres; *Ml.* Longitudinal muscle fibres; *Pm.* Peritoneal membrane.

latter case small particles would most probably be introduced into the alimentary canal. The narrowness of the oesophagus must, however, prevent any but the very smallest particles from being taken in.

There seems to be little doubt that the region of the alimentary canal called mid-intestine, is the place where digestion takes place, as every other part of the canal is strongly chitinised. As far as could be told from the sections obtained of the gut, there is no indication of a peritrophic membrane.

The mid-intestine reaches to the fifth abdominal segment, where it passes into the intestinal region of the hind-gut (*in.*). The brown colouration of the mid-intestine here ceases. Just at the juncture of

these two, four Malpighian tubules (*Mp.*) are given off from the extreme end of the mid-intestine. The right pair are given off somewhat dorsally, so that their point of origin may be distinguished when viewing the alimentary canal from above (Pl. I, fig. 13, *R. Mp.*).

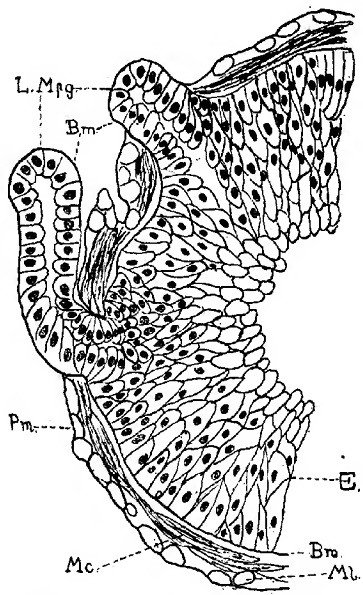


Fig. 8. Transverse section of the alimentary canal in the region of the Malpighian tubules. × 140.
Bm. Basement membrane; *E.* Epithelium; *L. Mpg.* Left Malpighian tubules; *Mc.* Circular muscle fibres; *Ml.* Longitudinal muscle fibres; *Pm.* Peritoneal membrane.

The left pair are inserted ventrally, the point of origin being visible from the ventral surface. Viewing the alimentary canal externally, it is difficult to say whether the Malpighian tubules are given off from the mid-gut or from the hind-gut. The transverse section of this part shown in Fig. 8 seems to prove that they are given off from the mid-gut, as there is no chitinous intima present. The epithelium consists of several layers, and the cells are smaller than those of the epithelium of the mid-gut shown in Fig. 7. The epithelial layer appears to be supported by a thin basement membrane (*B. m.*), which is continuous with the outer wall of the Malpighian tubules.

Seen in transverse section (Fig. 9), the Malpighian tubules are

found to consist of about ten irregularly arranged cells, which enclose a central lumen. The nuclei are large, and in some cases appear to have a granular structure. There is no fusion of the cells of the Malpighian tubules to form a syncitium. Both in longitudinal (Fig. 8) and in transverse section the cells are distinct from each other.

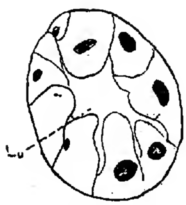


Fig. 9.

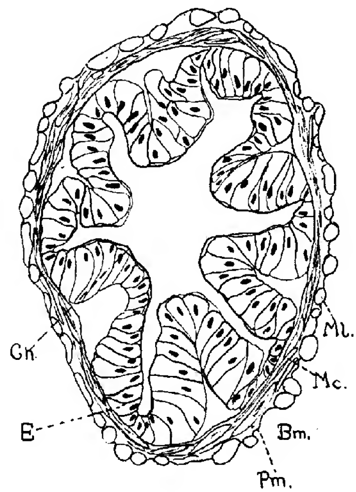


Fig. 10.

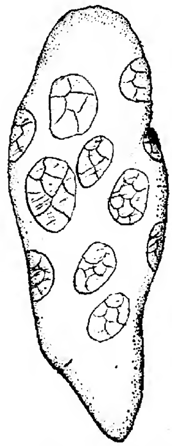
Fig. 9. Transverse section through a Malpighian tubule. × 140.
Lu. Lumen.

Fig. 10. Transverse section through the intestinal region of the hind-gut of the Larva. × 140.
Ch. Chitinous intima. Other lettering as before.

The hind-gut appears to commence almost immediately after the Malpighian tubules have been given off, for the character of the epithelium is soon found to change, and a thin, chitinous intima is present (Fig. 10, *ch.*). The epithelium here is only one layer of cells thick, and the lumen enclosed is relatively much larger than in the mid-intestinal region.

In close connection with the alimentary canal and with the Malpighian tubules are the abdominal fat bodies (Pl. I, fig. 12, *fb.*). They are usually of an orange colour, the shades varying in different larvae. They are always present and are usually attached to the alimentary canal by means of a thin transparent membrane. On the outer surface of the fat body a number of round, whitish markings may generally be observed (Fig. 11, *pb.*). On more detailed examination of

these by means of sections of the fat body, they are found to be caused by numerous pear-shaped bodies (Fig. 12, *pb.*). which radiate from a point about the centre of the fat body. They are enclosed by the fat tissue. Fig. 12 (*b.*) shows a figure of a pear-shaped body enlarged. There are a number of elongated dark markings, the nature of which has not been ascertained. They appear to be arranged in rings, somewhat resembling the lines on a starch grain. No definite cellular



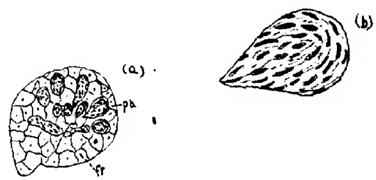


Fig. 12.

Fig. 11. Abdominal fat body of the Larva showing concretions. × 37.
Fig. 12. (*a*) Abdominal fat body in transverse section. × 30.
pb. Pear-shaped bodies. (*b*) Pear-shaped body. × 150.

structure could be made out. At first the presence of these bodies was thought to denote disease of that part of the insect, but as they were found to occur more or less abundantly in every larva examined, this idea did not seem possible. They appear to become more numerous and to increase in size as the larva reaches maturity. It seems highly probable that they are really concretions of an excretory nature. On examination of the fat body with acetic acid, a number of spherical crystals were to be observed, together with some concretionary forms. When the larva is fully grown the Malpighian tubules assume an attenuated appearance, while the abdominal fat bodies appear to consist almost entirely of the white pear-shaped bodies.

The hind-gut is divided into two regions, an intestinal region (Figs. 6, *in.*, and 10), and a rectal region (Figs. 6 and 13). The latter is wider than the intestinal region, and the chitinous intima has become considerably thicker (Fig. 13, *ch.*). The

epithelium (*E.*) has correspondingly decreased and is only represented by a very narrow layer of cells. Similarly the musculature is not nearly so well marked as in the intestine. The rectum opens to the exterior by an aperture surrounded by the soft, fleshy lobes of the telson. Both rectum and intestine were frequently found to contain a brownish fluid, visible through their semi-transparent walls, though during life only a colourless fluid was seen to issue from the anus. The whole of the alimentary canal is well supplied with branches from the tracheal system.

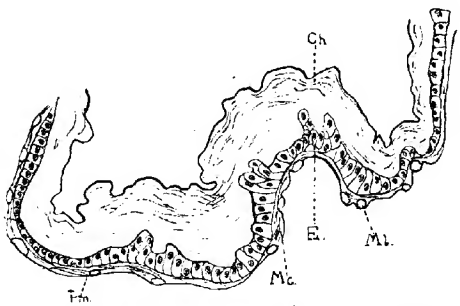


Fig. 13. Transverse section through part of the rectal wall of the Larva. × 140.
Ch. Chitinous intima. Other lettering as before.

c. The Mouth and Oral Cavity. (Pl. II, figs. 14 and 15).—The mouth opens between the bases of the mandibles, and is a slit about .7 mm. broad. This opening quickly narrows into the oesophagus, forming a funnel-shaped pharyngeal region (*ph.*). The oesophagus is about .3 mm. broad. Dorsally the mouth is formed by the under surface of the labrum, and the chitinisation of the labrum is continued down into the pharynx, where it is thickened for the attachment of muscles, which assist in the movements of the pharynx. The hinder ends of these muscles are inserted on the inner surface of the dorsum of the head. Ventrally the mouth is formed by the hypopharynx. Pl. II, fig. 14, shows the ventral surface of the mouth, the dorsal surface having been removed; the cut edge of the upper surface of the alimentary canal being marked by the letters *cte.*

The hypopharynx (*hyp.*) is a raised chitinous structure attached by folds of skin to the inner surface of the maxillo-labium. It is strengthened and supported by a horizontal heavily-chitinised bar (*hor.* in fig 14), from which two rod-like processes (*pr.*), also chitinised, project backwards and fit against the chitinous socket (*sk.*) of the maxillo-labium. This chitinous bar forms attachment for the muscles which move the whole maxillo-labium. These muscles are inserted on

thickenings of the fold of skin which unites the maxillo-labium to the head itself. Anteriorly the hypopharynx bears a fringe of hairs, whilst posteriorly it sends three chitinous thickenings down into the pharyngeal region of the alimentary canal, which serve to strengthen the canal in that region.

The mouth is bounded laterally by the mandibles which lie outside it. They take no part in the actual formation of the mouth, though the narrowness of the oesophagus inclines one to believe that the Telephorus larvae, as a rule, suck in their food, there is no indication that the mandibles are hollow or take any part in the actual act of sucking. When suction takes place it is probably by the muscular action of the maxillo-labium and hypopharynx.

d. The Heart.—Upon removal of the dorsal body wall, the heart may be seen as a slender vessel lying in the median line above the dorsal fat body, and is supported by nine pairs of alary muscles, which correspond with the first thoracic (Fig. 14, *th. al.*), and with the first eight abdominal segments (*ab. al.*) respectively. The alary muscles are inserted by five sheaths to lateral thickenings of the outer integument, situated in the fold of skin connecting the alary muscle itself and the segment directly behind it. Thin strands of membrane unite the alary muscles with each other (*um.*), and these strands extend forward for a short distance beyond the thoracic pair of muscles.

Numerous rounded pericardial cells are supported by these filamental strands, and many others lie along the alary muscles; the yellowish colour of the heart appears to be due to the abundance of these cells.

The central canal of the heart (*ht.*) is very narrow, and is apparently not divided into chambers, though its extreme narrowness and fragility make it very difficult to determine accurately. When removed, cleared, and stained it never shows the least appearance of being divided into valvular chambers, but seems rather to be a continuous muscular tube. Anteriorly it passes into a delicate aorta (*ao.*), passing below the brain (*br.*) and above the oesophagus between the oesophageal commissures. On reaching the head the aorta becomes still more delicate, and finally is impossible to follow, especially as the pericardial cells cease to occur before the aorta passes beneath the brain, and so the yellowish colour which helped to make the heart distinguishable is lost. Similarly it is impossible to trace it posteriorly. Several attempts were made to inject the heart with coloured solutions, but the canal was too narrow to allow the needle to be inserted.

e. The Tracheal System.—The tracheal system opens to the exterior by nine pairs of spiracles. The first and largest pair is

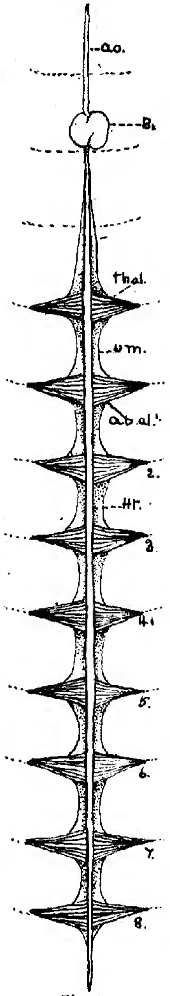


Fig. 14.

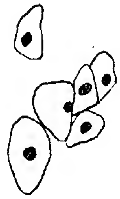


Fig. 15.

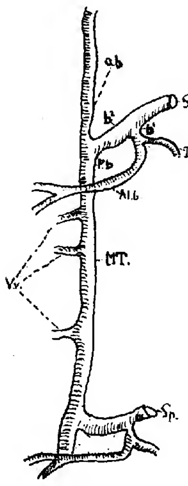


Fig. 16.

Fig. 14. The Heart of the Larva. × 13.

ab. al. Abdominal alary muscle; *ao.* Aorta; *Br.* Brain; *Ht.* Central Canal; *thal.* Thoracic alary muscle; *um.* Uniting membrane.

Fig. 15. Pericardial cells of the Larva. × 140.

Fig. 16. Tracheal system of the Larva seen from the right side of the 2nd abdominal segment, enlarged.

Al. b. Alimentary branch; b^1, b^2, First divisions of the tracheal tube: *Db.* Dorsal Branch; *MT.* Main Trunk; *Pb.* & *ab.* Posterior and anterior branches; *Sp.* Spiracle.

situated on the undersurface of the second thoracic segment, the remaining eight pairs all open on the sides of the first eight abdominal segments. The tracheal system throughout the abdomen follows a definite plan, the arrangement of the tracheal tubes being the same in

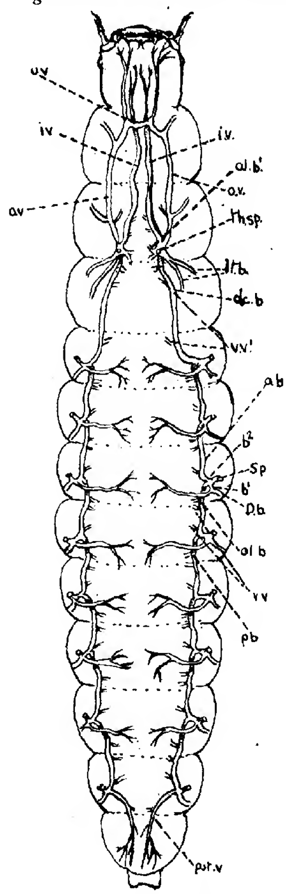


Fig. 17. Tracheal system of the Larva. × 7.
ab. Anterior branch; *al. b.* Alimentary branch; *al. b*¹. Alimentary branch in thorax; *b*¹, *b*², First divisions of the tracheal tube from *abd. sp.*; *Db.* Dorsal branch; *dc. b.* Descending branch; *i. v.* Inner vessel; *lt. b.* Lateral branch; *o. v.* Outer vessel; *p. b.* Posterior branch; *pst. v.* Posterior vessel; *Sp.* Spiracle; *th. sp.* Thoracic spiracle; *u. v.* Uniting vessel; *v. v.* Ventral vessels in thorax.

each segment. Both sides are alike, and therefore only one side need be described. The branch b^1 (Figs. 16 and 17) divides into an upper and a lower branch. The upper branch (*D.b.*) supplies the lateral and dorsal muscles, the lower branch (*al. b.*) passes inwards and supplies the alimentary canal. The branch b^2 also divides into two parts which pass anteriorly and posteriorly. The anterior vessel unites with a corresponding anterior one from the segment behind. This is repeated in every segment until a main tracheal trunk (*MT.*) is formed, which runs down the side of the body and gives off between each pair of spiracles three vessels (*vv.*), which supply the nerve cord and ventral muscles. In the last abdominal segment the tracheal system appears to end blindly in a number of ramifications (Fig. 17, *pst.v.*). There is no union of the right and left tubes in any of the abdominal segments. The thoracic spiracle (*th. sp.*) opens into a short tube from which five branches radiate. A descending branch (*dc. b.*) forms a continuation of the main tracheal trunk, and gives off a series of ventral vessels (*v.v.*) supplying the ventral muscles and nerve cord as before, and the third pair of legs. A lateral branch (*lt.b.*) supplies the lateral and dorsal muscles of the third thoracic segment. An inwardly directed vessel (*al.* b^1), which immediately divides the two branches, appears to supply the alimentary canal throughout the thorax, the two remaining branches passing forwards and supplying the mouth parts. The outer vessel (*o. v.*) gives off on its way lateral branches, which supply the lateral and dorsal muscles of the first and second thoracic segments. Just in front of the brain it gives off an inwardly directed branch, which unites with a corresponding one from the opposite side (*u v.*). This is apparently the only point of union between the right and left tracheal systems. After this the outer branch enters the head, and is lost in five ramifications of the muscles of the antennae and the mandibles. The inner ascending branch (*i. v.*), from the thoracic spiracle, appears to supply the maxillo-labium and the ventral surface of the head. On its way it gives off several ventral branches, which supply the second and first thoracic legs and the ventral muscles.

f. The Nervous System. (Pl. II, figs. 16—19).—The nervous system of the Telephorid larva presents a point of peculiarity in the position of the brain and sub-oesophageal ganglion.

The brain of insects, both larval and adult, with the exception of one or two dipterous larvae, usually appears to be situated in the head, whereas in the case of *Telephorus* it is always to be found in the lower half of the first thoracic segment (Pl. II, fig. 19, *Br.*). The meaning of this unusual position is not obvious. The brain of the Telephorid larva is found, on comparison with that of a similar sized Carabid larva,

to be only about half the size; considering the activity and intelligence of the Carabid larva, this is only what might be expected, for, as has before been mentioned, the Telephorid larva is extremely sluggish in its general habits, though it moves fairly quickly when frightened.

In structure the brain is bilobed, the left lobe (Pl. II., fig. 16, *Ll.*) always being slightly larger than the right lobe (*Rl.*). Anteriorly each lobe is produced into a short stalk (*St.*) from which three nerves proceed. The outer one (*op. n.*) runs forward and enters, from behind, the ocellus (*oc*) of the corresponding side; the median one (*an. n.*), which is also ventral to the other two, supplies the antenna (*an.*), whilst the third and inner one (*la. n.*) runs forward beside the alimentary canal and appears to penetrate the soft under-surface of the labrum, which forms the roof of the mouth. From the underside of each cerebral lobe towards the base, a nerve arises (Pl. II, fig. 16, *Sp. n.*) which passes backward and supplies the first thoracic spiracle. It becomes attached to the tracheal tube just before the spiracle is reached.

Directly below the brain lies the sub-oesophageal ganglion (Pl. II, figs. 17 and 18, *s. o. g.*). Viewed from the dorsal surface, after the removal of the alimentary canal, it is just visible below the brain. The oesophageal commissures (*com.*) which unite the brain and the sub-oesophageal ganglion, are delicate bands which arise from the under-side of the anterior end of the brain and unite with the upper surface of the anterior end of the sub-oesophageal ganglion. Three nerves arise from the upper surface of this ganglion. The first (*Md. n.*) lies somewhat in front of the insertion of the commissures, and after entering the head, bends outwards and passes between the fibres of the contractor muscle (*c. m.*) of the mandible. After entering the muscle the course of this nerve is extremely difficult to follow, and whether branches are sent to the extensor muscle has not been determined. The roots of the remaining two nerves lie close together. Nearest the insertion of the commissure lies the nerve (*mxl. n.*). This may be traced forwards and seen to enter the maxillo-labium and finally the maxillary portion of it. No branch has been traced to the small palp (*mx. p.*) The third nerve (*L. n.*) supplies the labial region of the maxillo-labium; it is an extremely fine nerve. At its base two small branches arise, the course of which has not been followed.

In the thorax (Pl. II, fig. 19) the three ganglia show no sign of fusion, the first thoracic ganglion (*th.* $g.^1$) lies in the same segment as the brain. There are seven abdominal ganglia (*ab. g.* 1-7), the first of which lies just inside the third thoracic segment; the second abdominal ganglion thus comes to lie inside the first abdominal segment, and in this way each of the abdominal ganglia is displaced and is situated in

the segment in front of the one to which it actually belongs. The seventh ganglion is slightly larger than the others; it is probably a fusion of the last three ganglia; it gives off a pair of nerves on each side, which supply the last three abdominal segments.

Both the thoracic and the abdominal ganglia send out a lateral nerve on each side. In the thorax this nerve is much stouter than in the abdomen, and it gives off a descending branch which supplies the leg. After this it enters the ventral muscles, where it splits up into a number of fine branches. These probably ramify all round the segment, as there appears to be no other nerve supply. Though repeatedly looked for, it has been impossible to trace any definite nerve supply to the alimentary canal. In one or two cases the spiracular nerve from the underside of the brain, appeared to send off fine branches to the crop. In no case do the lateral thoracic and abdominal nerves appear to have any connection with the alimentary canal, and there seems to be no sign of a sympathetic nervous system.

g. The Fat Body and Dorsal Glands.—

The Fat Body.—On removing the cuticle and the dorsal muscle strands, the alimentary is entirely obscured from view by a large, yellow, fat body, which in well-grown larvae extends from the posterior end of the body to the region of the brain. In each segment this fat body is continuous with a series of whitish-yellow fat bodies, which lie laterally in the body cavity, and are kept in place by the lateral muscles. These are again continuous with the fat bodies of the ventral surface, which lie below the ventral longitudinal muscle strands and are quite white in colour. Thus there is a complete gradation in colour from yellow to white, in what appears to be a continuous fat body. The lateral and ventral fat bodies are lobulate, and have a definite form, which is repeated in each segment. Slender, white fat bodies connect up the ventral and lateral bodies of each segment with each other.

Dorsal Glands.—When describing the external appearance of the larva (p. 15), a series of small pores, situated down each side of the dorsum, were referred to. These were present, a pair in each segment, both in the thorax and the abdomen. Further investigation shows that these pores communicate with a small glandular structure (Fig. 18), which lies just beneath the integument. The gland appears to be composed of polygonal nucleated cells. The entrance to the gland is guarded by a number of bristles (*br.*), which are inserted on a chitinous ring (*ch. rg.*).

It is not easy to understand the meaning of these glands, they are extremely minute, and nothing was ever seen to issue from them during life. Their extreme minuteness seems to preclude the idea that

they may be for defensive purposes. They may, however, render the animal distasteful to its enemies. It also seems possible that they may secrete a certain amount of liquid, which would enable the insect to withstand deprivation of moisture, especially when the length of time which a Telephorus larva can remain without moisture is remembered.

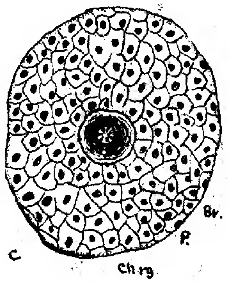
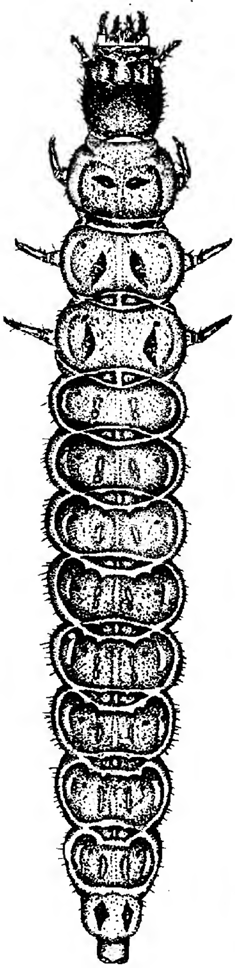


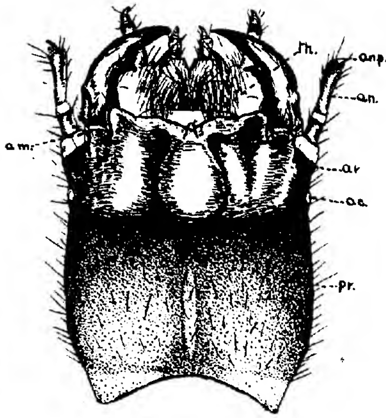
Fig. 18. Dorsal gland of the Larva. × 140.
Br. Bristles. *ch. rg.* Chitinous ring.

IX.—Bibliography.

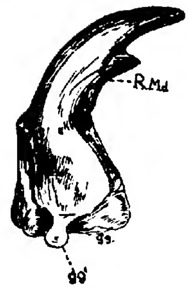
1. Beling, Th.—Beitrag zur Biologie einiges Käfer aus der Familie der Telephoridae. Berl. Ent. Zeits., 1885, Bd. xxix; pp. 350-362.
2. Cameron, A. E.—A note on two Species of Bassid Ichneumonidae parasitic on a species of Syrphid larva. Entomologist, April, 1913, pp. 130, 131.
3. Coquillett, D. W.—New food plant and enemy of *Icerya*. Insect Life, 1889, vol. ii, p. 49.
4. Deegener, P.—Nervensystem. In Schroder's Handbuch der Entomologie, 1912, pp. 77-139.
   ——— Der Darmtraktus und seine Anhänge. Ibid., pp. 235-309.
5. Dietrich, J. K.—Eniges aus dem gebiete der Schweigerischen Käferfauna. Stettin. Entomol. Zeit., 1857, Bd. xviii, pp. 117-138.
6. Eighth Report of the State Entomologist, 1891. New York State Museum.
7. Fowler, W. W.—The Coleoptera of the British Isles. 1890, vol. iv, pp. 138, 139.
8. Henneguy, L. F.—Les Insectes. Paris, 1904.
9. Hentz, N. M.—Remarks on the use of Maxillae in Coleopterous Insects, with an account of two Species of the Telephoridae. Trans. Amer. Phil. Soc., 1830 (s. 2), vol 3, pp. 458-463, 1 pl.
10. Kuhnt, P.—Illustrierte Bestimmungs Tabellen der Käfer Deutschlands. 1913.



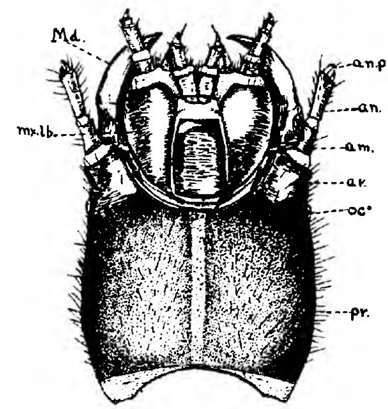
1.



2.

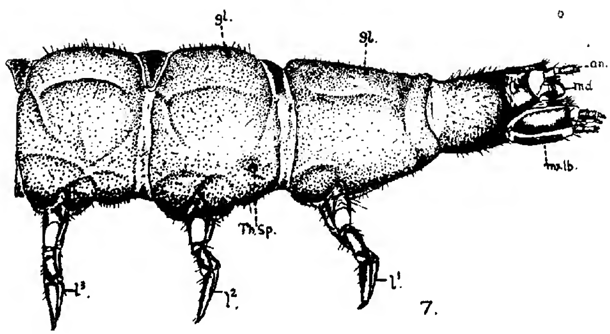


4.



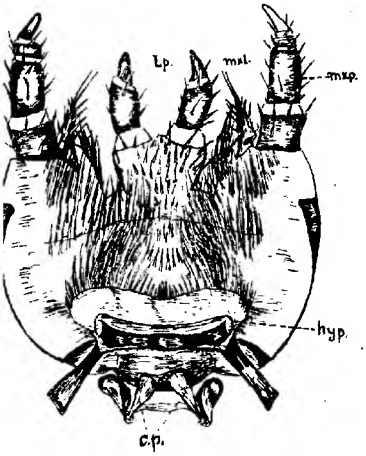
3.

5.

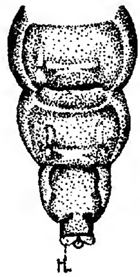


7.

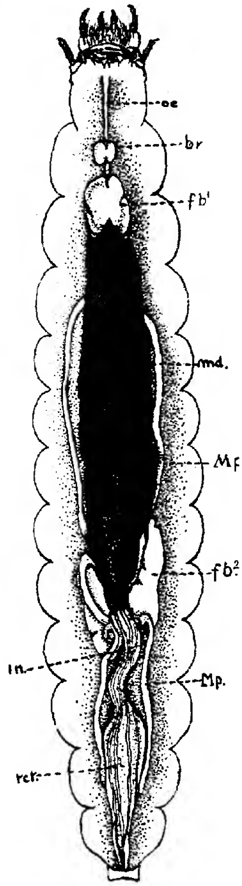
TELEPHORUS



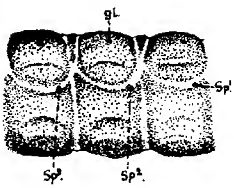
6.



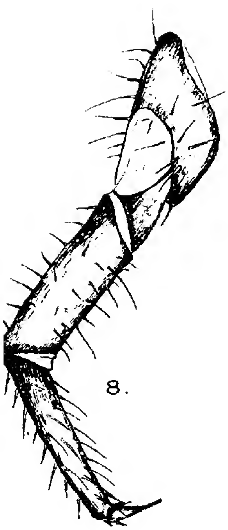
9.



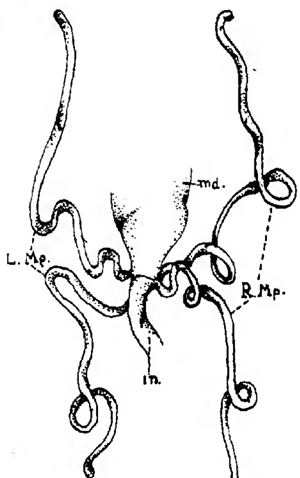
12.



10.



8.



13.

11.

RATUS, *Fallen.*

11. LUZE, G.—Die Metamorphose von *Cantharis abdominalis*, Fabr. Berl. Ent. Zeits., 1902, Bd. xlvii, pp. 239-242.
12. MIALL, L. C., AND DENNY, A.—Structure and Life-History of the Cockroach. London, 1886.
13. ORMEROD, E. A.—Report of Observations of Injurious Insects and Common Farm Pests. 22nd Rpt., 1899.
14. PACKARD, A. S.—A Text-book of Entomology. 1903.
15. PLATEAU, F.—Recherches sur les phémomènes de las digestion shez les insectes. Mem. Acad. Roy. Belgique, 1873 (s. 2), t. xli, 1re Partie.
16. POPENOE, C. H., AND SMITH, E. G.—An Epidemic of Fungus Diseases among Soldier Beetles. Proc. Ent. Soc. Washington, 1911, vol. xiii, pp. 75, 76.
17. REMER, W.—Weichkäfer Gattung *Telephorus*. Jahres. Schles. Gesell. für Vat. Kultur, 1903, pp. 12, 13.
18. REMGIUS, H.—Der Darmkanal (der Imago und Larve) von *Dytiscus marginalis*, L. Zeit. f. wiss. Zool., 1911, Bd. xcviii, pp. 179-287.
19. SAMSON, K.—Uber das Verhalten der Vasa Malpighii und die excretorische Function der Fettzellen während der Metamorphose von *Heterogenea limacodes* (Hagn.). Zool. Jahrb. (Abt. f. Anat.), Jena, 1908, Bd. xxvi, pp. 403-422, 2 Taf.
20. SCOTT, J.—Are *Telephorus rusticus* and *Telephorus lividus* the male and female of one species? (in copula capt.). Zoologist, 1853, vol. ii, p. 3919.
21. STRAUS-DURCKHEIM, H.—Considérations générales sur l'anatomie des animaux articules. 1828.
22. TASCHENBURG, E. L.—Praktische Insektenkunde. (Weichkäfer Gattung). 1880, Bd. ii.
23. WATERHOUSE, G. R.—*Telephorus rufus*. Trans. Ent. Soc. Lond., 1834, vol. i, p. 39, pl. 3.
24. WESTWOOD, J. O.—An Introduction to the Modern Classification of Insects. 1839, vol. i, pp. 255-258.

EXPLANATION OF PLATES I AND II.

Illustrating Miss Olga G. M. Payne's paper "On the Life-history and Structure of *Telephorus lituratus*, Fallen."

PLATE I.

Fig. 1. Larva of *Telephorus lituratus*, viewed from above. × 7.

Fig. 2. Head of same, dorsal surface. × 23.5 *am.* articulation of mandible; *an.* antenna; *an. p.* antennary processes; *ar.* anterior region of the head; *oc.* ocellus; *pr.* posterior region of the head; *th.* median tooth-like process.

Fig. 3. Head, ventral surface. × 23. *am.* articulation of mandible; *m. lb.* maxillo-labium; other lettering as above.

Fig. 4. Right mandible. × 54.

Fig. 5. Left mandible. × 54. *gg.* ginglymus.

Fig. 6. Maxillo-labium, inner surface. × 58. *c.p.* chitinous processes for attachment of muscles; *hyp.* hypopharynx; *lp.* labial palp; *mxl.* maxilla; *mx.p.* maxilllary palp.

Fig. 7. Head and thoracic segments, viewed from the side. × 14. *gl.* position of glandular orifice; *l.*[1] *l.*[2] *l.*[3] 1st, 2nd, and 3rd legs; *th. sp.* thoracic spiracle; other lettering as before.

Fig. 8. Right leg, belonging to first thoracic segment. × 147.

Fig. 9. Posterior abdominal segments, viewed from the ventral surface. × 8. *tl.* telson.

Fig. 10. First three abdominal segments, viewed from the side. × 12. *gl.* position of glandular orifice; *sp.*[1]—*sp.*[3] first three abdominal spiracles.

Fig. 11. Eggs of *Telephorus lituratus.* × 10.

Plate II.

Fig. 12. Alimentary canal of *Telephorus lituratus* dissected from the dorsal surface. × 10. *br.* brain; *fb.*[1] anterior fat body; *fb.*[2] posterior fat body; *in.* intestine; *md.* mid-intestine; *Mp.* Malpighian tubule; *oe.* oesophagus; *rct.* rectum.

Fig. 13. Region of alimentary canal with Malpighian tubules. × 18. *in.* intestine; *L. Mp.* left Malpighian tubule; md. mid-intestine; *R. Mp.* right Malpighian tubule.

Fig. 14. Larval mouth dissected to show lower surface. × 28. The formation of the mouth in connection with the hypopharynx is here shown—the upper surface attached to the labrum has been removed. *cr.* crop; *cte.* cut edge of pharynx; *dl. ph. m.* dorsal pharyngeal muscles; *hyp.* hypopharynx; *md.* mid intestine; *oe.* oesophagus; *ph.* pharynx; *pr.* chitinous processes which support the hypopharynx.

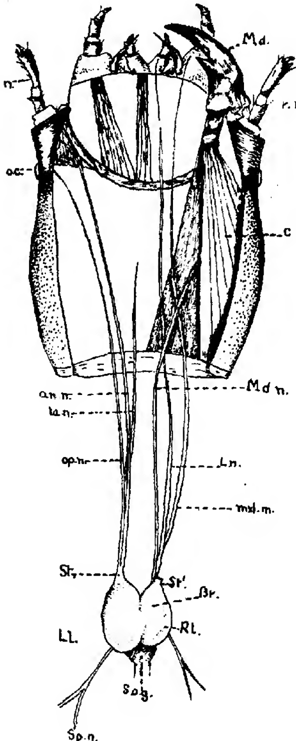
Fig. 15. Hypopharynx, viewed from below after removal of the maxillo-labium. × 23. *hor.* chitinous bar which takes part in the formation and support of the hypopharynx; *sk.* chitinous rim to which the maxillo-labium is attached; *th.* chitinous processes from the hypopharynx which support the pharynx.

Fig. 16. Dissection showing brain and nerves of the head. × 24. *an. n.* antennary nerve; *Br.* brain; *c. m.* contractor muscle of the mandible; *LL.* left lobe of the brain; *la. n.* nerve to labrum; *Ln.* labial nerve; *mxl. n.* maxillary nerve; *Md. n.* mandibular nerve; *op. n.* nerve to ocellus; *RL* right lobe of the brain; *sp. n.* spiracular nerve; *S. og.* sub-oesophageal ganglion.

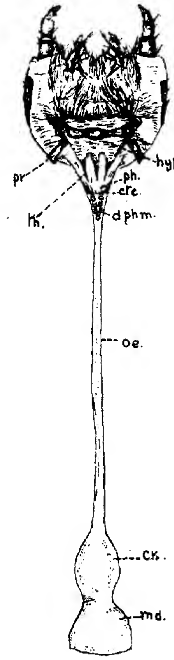
Fig. 17. Sub-oesophageal ganglion. × 35. *com.* commissures; other lettering as before.

Fig. 18. Brain and sub-oesophageal ganglion, viewed from the side. × 35. Lettering as before.

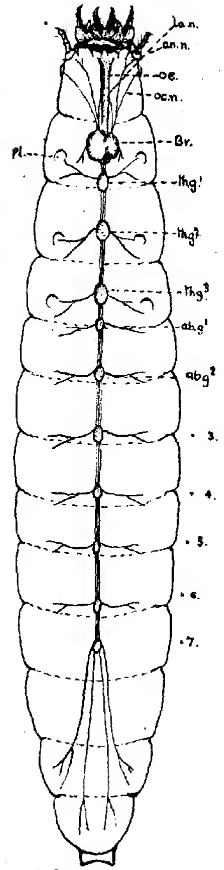
Fig. 19. Entire nervous system dissected from the dorsal surface. × 9. *abg.*[1]—*abg.*[7] abdominal ganglia; *th. g.*[1], *th. g.*[2], *th. g.*[3] thoracic ganglia; other lettering as before.



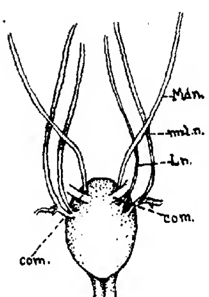
16.



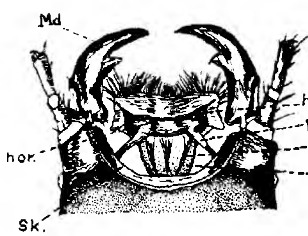
14.



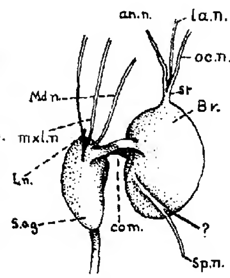
19.



17.



15.



18.

TELEPHORUS LITURATUS, *Fallen.*

DESCRIPTION OF A NEW SPECIES OF MARINE ISOPODA OF THE GENUS *PENTIAS*, RICHARDSON.

By WALTER E. COLLINGE, M.Sc., F.L.S., etc.,

Research Fellow of the University of St. Andrews.
The Gatty Marine Laboratory, St. Andrews.

With Plate III.

The genus *Pentias* was founded by Miss Richardson,[1] in 1904, for the reception of a Japanese species of Isopoda belonging to the family Idoteidae, characterized by the following structural features:—

The flagellum of the antenna consists of six short joints, the maxillipede has a five-jointed palp, and the metasome is composed of a single segment.

In describing the type, *P. hayi*, the authoress remarks that the "genus differs from all other known genera of Idoteidae except *Glyptidotea*, Stebbing, and *Crabyzos* in having the maxillipedes with a five-jointed palp." This feature, however, is common to the genus *Zenobiana*, Stebbing,[2] and is since known to occur in *Mesidotea*, Richardson, *Pentidotea*, Richardson, *Cleantiella*, Richardson, and *Engidotea*, Barnard.

For the opportunity to examine the species here described, and many other members of the Idoteidae in the collection of University College, Dundee, I am indebted to the kindness of Professor D'Arcy W. Thompson, C.B., whose name I have pleasure in associating with the present new species as a slight acknowledgment of his many kindnesses.

Pentias thompsoni, n. sp.

Pl. III, figs. 1—10.

Body oblong ovate, mesosome wider than the metasome, convex dorsally. Cephalon (fig. 1) wider than long, and wider anteriorly than posteriorly; anterior margin curved inwards, surface rough. Eyes much wider than long, situated laterally in front of the transverse median line. Antennulae (fig. 2) short, 1st joint widely expanded, 2nd and 3rd

---

[1] Proc. U.S. Nat. Mus., 1904, vol. xxvii, p. 47, 2 figs.

[2] Miss Richardson's statement that *Z. occidentalis* (Richardson) and *Z. heathi* (Richardson) have 4-jointed palps requires confirmation. (Bull. No. 54, U.S. Nat. Mus., 1905, pp. 406, 407).

[Journ. Zool. Research, April, 1916, vol. i, No. 1.]

joints small; flagellum a short, oval, single joint. Antennae (fig. 3) comparatively short, 1st joint very small, 2nd stout, 3rd small, 4th and 5th longer and wider distally; flagellum with six short joints. First maxillae (fig. 4), outer lobe with eleven stout, curved, terminal spines, arranged in four rows, setaceous on the inner side; inner lobe with three setose spines, and setule on the distal outer border; setaceous on the inner side. Maxillipedes (fig. 5) elongate, with 5-jointed palp, basal plate short, epipodite short and wide, divisions of the coxopodite large. The segments of the mesosome (fig. 6) more or less subequal, pleural plates of the 1st extending forwards and partly flanking the cephalon, anteriorly they are bluntly pointed, posteriorly cut away and overlapping the 2nd segment. Coxal plates small, occupying the anterior marginal half of segments 2—7; each plate anteriorly extends beyond the segment. Appendages of the mesosome (figs. 7 and 8) somewhat slender, 2nd to 4th short, 5th to 8th much longer. Metasome (fig. 9) composed of a single segment and two lateral sutures indicating coalesced ones, in addition to a third suture extending across the metasome; terminal segment gradually widening until posteriorly the lateral margins are produced as blunt points, beyond which the posterior margin slopes acutely, terminating as a blunt point. Uropoda (fig. 10) short, inner margin straight, outer margin curved in slightly and narrower anteriorly than posteriorly; endopodite somewhat triangular in shape, setose style short.

Length, 19.5 mm. Colour (in alcohol), deep rusty brown.

Habitat.—Yokohama, Japan.

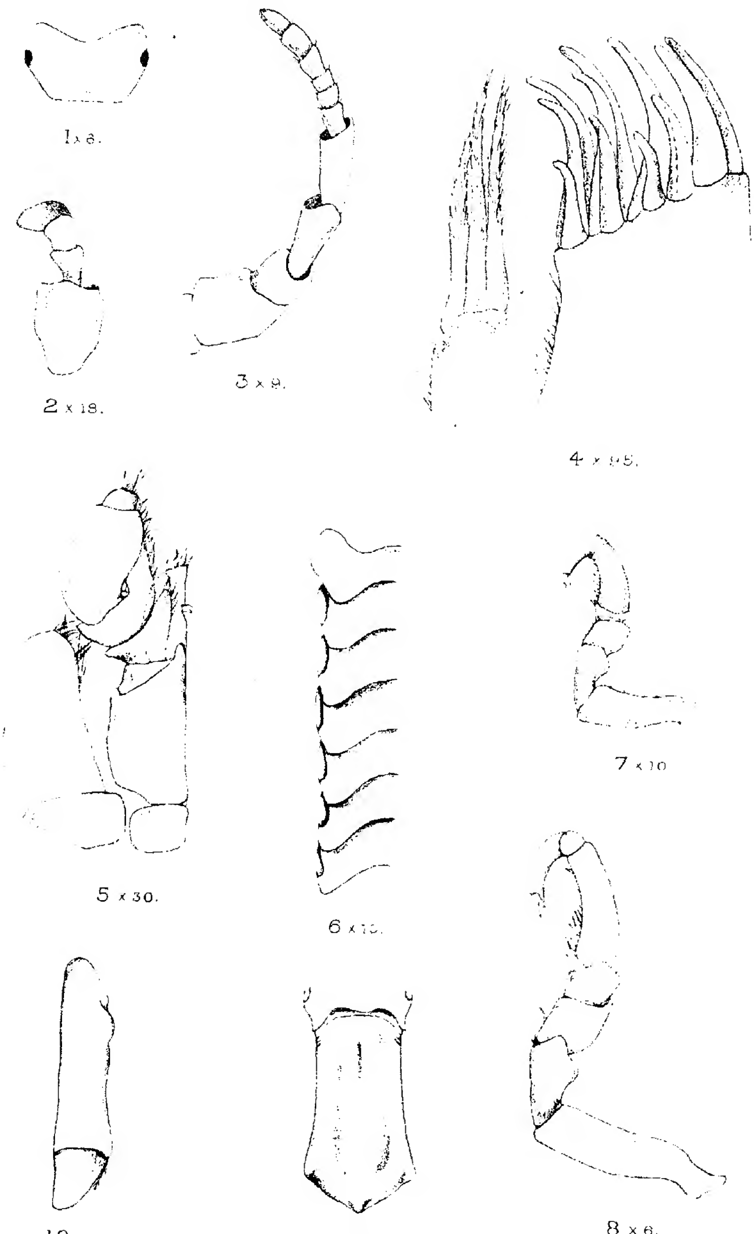
Type.—In the Museum of University College, Dundee.

Remarks.—*P. thompsoni* differs from *P. hayi* in its wider and more robust mesosome, in the shape of the cephalon and 1st mesosomatic segment, in the development of the coxal plates, the form of the maxillipede, and in the expanded form of the metasome.

The form of the antennulae and antennae are quite unlike those of any other genus of the family. In the outer lobe of the 1st maxillae the terminal spines are arranged in rows; in the first two rows there are three spines in each, in the third row there are also three, but not so symmetrically placed, whilst the fourth and outermost row has only two spines.

The maxillipedes are elongated, with the 5-jointed palp fully half again as long as the basal plate. The divisions of the coxopodite are comparatively large. I cannot help but think that Miss Richardson's figure[1] of the maxillipede of *P. hayi* is incorrect.

[1] *Op. cit.*, p. 48, fig. 25.



H S K del. ad nat.

Huth, London.

PENTIAS THOMPSONI, *n. sp.*

The coxal plates are visible dorsally on all the segments of the mesosome excepting the first, and occupy the anterior half only of each segment. In *P. hayi* they are largest on the 6th and 7th segments, where they occupy the whole of the lateral margin. In *P. thompsoni* they are largest on the 2nd and 3rd segments, becoming smaller posteriorly.

The metasome is rather narrower than the mesosome, and is composed of a single segment with a transverse suture passing from side to side. At first sight this has the appearance of a second segment, but I have fully satisfied myself that this line is quite superficial; there are also two lateral sutures at the commencement of the terminal segment.

DESCRIPTION OF PLATE III.

Illustrating Mr. Walter E. Collinge's paper, "Description of a new Species of Marine Isopoda of the Genus *Pentias*, Richardson."

Pentias thompsoni, n. sp.

Fig. 1. Dorsal view of the cephalon. × 6.

Fig. 2. Dorsal view of the left antennule. × 18.

Fig. 3. Dorsal view of the left antenna. × 9.

Fig. 4. Ventral side of the terminal portions of the inner and outer lobes of the left 1st maxilla. × 95.

Fig. 5. Ventral side of the right maxillipede. × 30.

Fig. 6. Dorsal view of the lateral portions of the mesosomatic segments, showing the coxal plates. × 10.

Fig. 7. Ventral view of the 2nd thoracic appendage. × 10.

Fig. 8. Ventral view of the 8th thoracic appendage. × 6.

Fig. 9. Dorsal view of the metasome. × 5.

Fig. 10. Left uropod. × 7.

REVIEWS.

THE MECHANISM OF MENDELIAN HEREDITY. By T. H. Morgan, A. H. Sturtevant, H. J. Muller, and C. B. Bridges. Pp. xiii + 262, 64 figs. London: Constable & Co., Ltd., 1915. Price 12s. net.

Of the genetic research published in recent years there is little to vie in interest or importance with that which has grown up round the pomace fly, *Drosophila ampelophila*, in America. From the remarkable number of Mendelian characters it presents, and from the rapidity and ease with which it can be bred, it is unrivalled as material for such research, and though it is but a few years since the first paper on its heredity was published, it has to-day a literature of its own, rich in novelty and interest. To Professor Morgan and his co-workers we owe most of what is known to-day about this little species, and he has placed biologists under a further debt to him by the publication of the present volume. His researches on *Drosophila* and other species have led Morgan to see in the chromosomes the mechanism of Mendelian heredity, and this book is avowedly a statement of that point of view. At the same time, it is written for the biologist in general as well as for the genetic expert, care being taken, as is stated in the preface, to separate what appears significant from what is special or merely technical. He treats of heredity as a problem concerning the cell, the egg, and the sperm, and attempts to correlate the facts of inheritance with the phenomena shown by the behaviour of the chromosomes.

After a brief introduction to Mendelian segregation and the types of Mendelian inheritance the authors discuss the phenomenon of linkage of characters either with sex or with one another. Great stress is naturally laid upon the most striking feature in *Drosophila*, namely, that the hundred or more factors for characters identified in *Drosophila* can be classified in four groups. Any member belonging to one of these groups always exhibits linkage, more or less complete, with regard to any other member of the same group, while there is no linkage between members belonging to different groups. Moreover, the members of one group, and of one only, always exhibit linkage with sex. The great importance of this is evident when it is remembered that the number of chromosomes in *Drosophila* is four, the deduction being obvious and almost irresistible that each of the four groups of factors corresponds with and is contained by each one of the chromosomes. The difficulty that the linkage in the female is not complete is surmounted by a most ingenious hypothesis, on which it is suggested that when homologous chromosomes pair, they twist round each other in such a way that on separation each contains a

portion of the other, thus effecting a transference of hereditary factors between the members of a homologous pair.

The book presents the most cogent case yet put forward for the close connection between hereditary factors and chromosomes, and deserves the most careful consideration from cytologists as well as from students of heredity. The clearness with which it is written, together with the well-chosen illustrations and diagrams, should all help to ensure a welcome for a book which treats of one of the most important and novel lines of biological research.

R. C. Punnett.

A Monograph of the British Marine Annelids. Polychaeta. Vol. III, pt. i. Text, pp. viii + 368, pt. ii. Plates lxxxviii—cxi. By W. C. M'Intosh. London: Dulau & Co., Ltd., 1915. Price 25s. net each.

To the general public the Polychaete worms, if not positively repulsive, are at all events unattractive animals, of little significance. Yet every marine zoologist knows that among them are some of the most beautiful and most interesting of living creatures. It is to the Polychaeta we have constantly to turn for the solution of many of the most important problems in comparative anatomy and physiology. They often puzzle the naturalist, collecting on the shore or with the dredge, in their bewildering variety of form and colour.

"What is its name?" is one of the first questions we have to decide when embarking on the study of any animal, and hitherto it has been very difficult to answer this question satisfactorily with regard to the very numerous "Bristle worms" frequenting our shores.

Although much has been written on them, the literature is very scattered and often out of date, the descriptions insufficient, the synonymy confused; a single comprehensive work was therefore greatly needed. For over thirty years the veteran zoologist of St. Andrews has devoted himself to the production of a complete and adequate treatment of British Polychaeta, and all students of the marine fauna of these islands will be grateful to Professor M'Intosh for the result of his labours presented in such attractive form in this magnificent monograph.

The two new parts before us make up Volume III of the work, and deal with the families Opheliidae to Ammocharidae—including such diverse forms as the Scalibregmidae, Sphaerodoridae, Telethusae (Arenicolidae), Choraemidae, Chaetopteridae, Spionidae, Cirratulidae, and Maldamidae. The author gives a detailed account of every species: not only of its external features, but also of its internal anatomy. Much interesting information is inserted concerning the structure, habits, and distribution of the worms, both from the author's own experience and from the observations of other writers. Full references to the literature are given, also a very complete list of synonyms. No less valuable than the text are the numerous excellent plates illustrating this volume. As in previous parts, most of the

figures are reproduced from the beautiful sketches made from nature by the author's late sister, Mrs. Albert Günther, and by Miss A. H. Walker. Unfortunately, owing to the war, it has not been possible as yet to issue six plates in colour; but it was wisely decided to publish provisionally uncoloured copies of the proofs, so as not unduly to delay the appearance of the work.

So far Professor M'Intosh has not discussed the classification of the whole Class Polychaeta, the relationships of the various families to each other, and their possible grouping into Orders according to their true phylogenetic affinities. He does not appear to accept the conclusions of Levinsen or Benham, but promises a fuller treatment of this important and difficult subject in some future part, to the reading of which we look forward with the greatest interest.

Both the author and the Ray Society are to be heartily congratulated on the publication of this volume of a learned and most valuable contribution to British zoological science.

E. S. Goodrich.

The Embryology of the Honey Bee. By J. A. Nelson. Pp. iv + 282, 95 text figs. and 6 plts. Princeton University, Princeton. London: Humphrey Milford, Oxford University Press, 1915. Price 8s. 6d. net.

The embryology of the honey bee has been to some extent elucidated by a considerable number of zoologists, including such eminent investigators as Weismann, Bütschli, Kowalevski, and Grassi. The account given by the last-named author has been the completest up to the present. Being published in the *Atti dell 'Academie Gioenia di scienzi naturali of Catania* (1884), it is not so widely known as its merit undoubtedly warrants. Since that date the subject of insect embryology has made rapid advances, and improved methods of technique have come into vogue. Grassi's work is admirably correct in so far as it goes, while Mr. Nelson's treatise marks a notable advance on the histological side of the subject. The value of the present book is further enhanced by the author's wide acquaintance with the literature of his subject, and the comparisons which he institutes with other and allied forms. His account of Mitosis in the cleavage cells of both the fertilised and unfertilised eggs, though brief, confirms the observations of Nachtstein, though he is unable to tell us definitely whether the latter writer's estimate of 32 chromosomes is correct or not. The accounts of the formation of the blastoderm, mesoderm, and the mesenteron are admirable, and a most useful summary is given of the many and diverse views that are held with regard to the methods of development of the mid-gut among insects. The bee-embryo consists of twenty-one segments including the telson, but no abdominal appendages were formed. Separate coelomic sacs are not present, the somatic and splanchnic layers of mesoblast being continuous longitudinally throughout the trunk. Nelson confirms previous observers as to the presence of embryonic "tritocerebral

appendages," but he disagrees with Bütschli in regarding them as giving rise to a kind of larval lower lip. On the other hand, he finds that they disappear entirely and that their supposed significance is more than doubtful, being rather of the nature of ridges of neurogenic tissue. No trace of a superlingual or maxillular segment is to be detected.

A very full account of the nervous system is given, including that of the newly-hatched larva, and the development of the other organs are also very adequately treated. The total period normally required for the development of the egg is 76 hours. Cleavage occupies from 14-16 hours; blastoderm formation 14-16 hours; formation of the mesoderm, rudiments of mesenteron and embryonic envelope 12-14 hours; and the remainder of development 32-36 hours. The book concludes with a useful 8-page summary of the general facts of the development and a bibliography. The text-figures are all good, and the half-tone plates express all that they are intended in a perfectly clear manner. We have no hesitation in recommending this book as an introduction to the study of embryology among the Insecta.

A. D. IMMS.

THE INVERTREBRATE FAUNA OF NOTTINGHAMSHIRE. By J. W. Carr. Pp. viii + 618. Nottingham: J. and H. Bell, Ltd., 1916. Price 17s. 6d. net.

Many of the Natural History Societies of this country have planned the publication of county records of the fauna, but few of them have ever come to maturity; we therefore congratulate the Nottingham Naturalists' Society on the issue of the present handsome and well-printed volume.

The work was commenced in 1902 and the task of collecting and arranging the work was entrusted to Professor J. W. Carr, who has carried it out in a manner leaving little to desire.

In the present volume only the invertebrates are dealt with, and, we are informed, that it does not pretend to be more than a contribution to the subject, showing what has been accomplished and how much remains to be done.

Some idea of the extent of the work done may be obtained by quoting the number of species recorded in a few of the different groups and orders. Thus we have:—87 Oligochaeta; 25 Crustacea; 10 Chilopoda; 14 Diplopoda; 4 Thysanura; 29 Colembola; 20 Orthoptera; 410 Hemiptera; 933 Lepidoptera; 1,409 Coleoptera; 921 Diptera; 892 Hymenoptera; 207 Araneae; and 19 Acarina. The total number of species recorded is 5,330.

Nothing seems to be known of the Nematoda, the free-living Turbellarians, the Hirudinea, or the much-neglected Symphyla and Pauropoda. Only 8 species of terrestrial Isopods (Woodlice) are recorded, 6 species of Entomostraca, 3 species of Copepoda, 2 species of Dermaptera, and 2 of Thysanoptera. We merely mention these as showing that there is still plenty of work for Nottingham naturalists,

and to emphasise the fact that these lesser-known groups and orders are equally as interesting as the larger and commoner ones.

The nomenclature throughout is up-to-date, though we notice a few doubtful names, and the text is very free from errors.

W. E. C.

A Course in Invertebrate Zoology. A Guide to the Dissection and Comparative Study of Invertebrate Animals. By H. S. Pratt. Revised edition. Pp. xii + 228. Boston and London: Ginn & Co., 1915. Price 6s.

The scope and aim of Professor Pratt's work are both admirable, and in something less than two hundred pages he gives very complete instructions for the examination of over three dozen invertebrate animals. The descriptions are of necessity brief, but always clear.

Should a further edition be called for, we trust that the classification, given as an appendix, will be brought up to date. To find the sponges classed as a subphylum of the Coelenterata, and the Polyzoa and Brachiopoda as subphyla of "Vermes," is somewhat distressing. Pages 197-205 require to be very thoroughly revised, or else entirely omitted, for as they stand at present they are misleading to the student, and incorrect as a synopsis of the modern classification of animals.

W. E. C.

Evolution. By J. A. S. Watson. Pp. vii + 153 and 146 figs. London: T. C. and E. C. Jack, 1915. Price 5s. net.

As an elementary and popular exposition of the subject of evolution, Mr. Watson's well-illustrated book will undoubtedly prove most useful and interesting to a wide circle of readers.

In a clear and concise style he covers a wide ground: thus we first have the evidence for evolution presented, then a dissertation on unicellular and multicellular animals, with excellent figures; an interesting chapter is devoted to a consideration of the worms and some of their posterity, followed by others on the early vertebrates and the fishes, the conquest of the land, and finally one dealing with the mammals and man.

The subject matter has been well chosen, and most of the figures are good, some exceptionally so.

We notice a few unfortunate errors in the spelling of the scientific names, as well as in such words as Axolotl and Neanderthal. Apart from these the work is an instructive one, and will appeal to a wide class of readers.

and to emphasise the fact that these lesser-known groups and orders are equally as interesting as the larger and commoner ones.

The nomenclature throughout is up-to-date, though we notice a few doubtful names, and the text is very free from errors.

W. E. C.

A Course in Invertebrate Zoology. A Guide to the Dissection and Comparative Study of Invertebrate Animals. By H. S. Pratt. Revised edition. Pp. xii + 228. Boston and London: Ginn & Co., 1915. Price 6s.

The scope and aim of Professor Pratt's work are both admirable, and in something less than two hundred pages he gives very complete instructions for the examination of over three dozen invertebrate animals. The descriptions are of necessity brief, but always clear.

Should a further edition be called for, we trust that the classification, given as an appendix, will be brought up to date. To find the sponges classed as a subphylum of the Coelenterata, and the Polyzoa and Brachiopoda as subphyla of "Vermes," is somewhat distressing. Pages 197-205 require to be very thoroughly revised, or else entirely omitted, for as they stand at present they are misleading to the student, and incorrect as a synopsis of the modern classification of animals.

W. E. C.

Evolution. By J. A. S. Watson. Pp. vii + 153 and 146 figs. London: T. C. and E. C. Jack, 1915. Price 5s. net.

As an elementary and popular exposition of the subject of evolution, Mr. Watson's well-illustrated book will undoubtedly prove most useful and interesting to a wide circle of readers.

In a clear and concise style he covers a wide ground: thus we first have the evidence for evolution presented, then a dissertation on unicellular and multicellular animals, with excellent figures; an interesting chapter is devoted to a consideration of the worms and some of their posterity, followed by others on the early vertebrates and the fishes, the conquest of the land, and finally one dealing with the mammals and man.

The subject matter has been well chosen, and most of the figures are good, some exceptionally so.

We notice a few unfortunate errors in the spelling of the scientific names, as well as in such words as Axolotl and Neanderthal. Apart from these the work is an instructive one, and will appeal to a wide class of readers.

The Journal of Zoological Research.

Vol. 1.	JUNE, 1916.	No. 2.

Contents.

Surplus Literature for Sale.

	£	s.	d.
Annals Applied Biology. Vol. 1, 1914-15 - -		15	0
,, Trop. Med. and Parasit. Vols. 1-5 - -	3	0	0
,, ,, ,, ,, ,, Vol. 6 (No. 2 missing), and vols. 7-9 -	2	0	0
Bezzi. Syrphidae of Ethiopian Region, 1915 - -		3	6
Loew. Diptera of Nth. America. Pt. i, 1862 - -		3	6
Osten Sacken. Do. do. Pt. ii, 1869 - -		4	6
Marcellia. Vols. 9-13, as pub. - - - -	1	10	0
Monthly Bulletin (devoted to Econ. Entomol.). Vol. 1, cl.		10	0
,, ,, ,, Vols. 2, 3 and 4 - -	1	1	0
Proc. Assoc. Ec. Entom, U.S.A., 9th to 14th, and 15th to 19th meetings. 2 vols., cl. - - -		17	6
Stiles and Haswell. Index Med. and Vet. Zool. 2 vols, cl., and pts. 22-36, as pub. - - -	2	0	0
Trans. Entom. Soc. Lond. 1915 as pub. - -	2	0	0
Redia. Vol. 2, pl. 1, 1904 - - - -		5	6
,, Vols. 9, 10 and 11, as pub. - - -	1	11	6
Bibliog. Amer. Econ. Entom. Pts. 1, 2, 5, 6 and 7, as pub. - - - - - -	1	5	0
Eissig, E. O. Inj. and Benef. Insects of Calif. Cl. -		6	0
Newman, E. Letters of Rusticus, 1849. Cl. - -		3	6
Rev. of Applied Entom. Ser. A. and B. Vol 1, as pub.		7	6
Riley, C. V. Rpts. on Noxious and Benef. Insects State of Missouri. Nos. 1-9 and Index. 2 vols. ½ cf. -	6	0	0
Whitehead, C. Rpts. on Inj. Insects. 7 Rpts. 1855-1890, as pub. - - - - -		5	0
Journ. Lond. Sch. Trop. Med. Vols. 1 and 2, as pub.		15	0
Welcome Research Lab. Rpts. 1st, 2nd and 3rd -	1	5	0
,, ,, ,, ,, 4th Rpt. Vol. B -		7	6
Reh, L. Handb. Pflanzenkrankheiten. Bd. 3, 1913 -	1	0	0
Journ. Econ. Biology. Vols. 1-8 in cl. - - -	7	0	0

W. E. COLLINGE, 3, Queen's Terrace, St. Andrews, Scotland.

THE
JOURNAL OF ZOOLOGICAL RESEARCH.

THE RESPIRATORY SYSTEM OF *NEPA CINEREA*, LINN.

By S. MAULIK, B.A., F.E.S.

WITH 17 TEXT-FIGURES.

INTRODUCTION.

At the suggestion of Mr. Balfour-Browne I undertook the investigation of the respiratory system of *Nepa cinerea*, Linn. The conclusions arrived at are set forth in the present paper. The interest lies in two facts: (1) The respiratory system of the nymph undergoes remarkable changes when it becomes adult; (2) all these changes take place suddenly at the last moult of the nymph. The last fact suggests an interesting question: although both the nymphal and adult forms are to be found in the same place, that is to say, they live in the same environment, why should such difference exist between them so far as the respiratory system is concerned? It is difficult to answer this question without going into the oecology completely and without watching it for several seasons successively. I had not the opportunity to do this within the short period at my disposal. In the light of the observations I have been able to make, I shall suggest a reply at the end of this paper, after describing the structures concerned and indicating the changes that take place when the nymph attains maturity.

Nepa cinerea is a well-known water-bug found in almost every stagnant pool. The full-grown insect is characterized by two things, firstly, it has a long tail-like process at the end of the body, commonly called the siphon or the breathing tube; secondly, the fore-legs are raptorial. Owing to these legs it has a superficial resemblance to a scorpion, whence the popular name "water-scorpion." The nymph resembles the adult, but has no siphon or wings. Its cuticle is much thinner than that of the adult.

Nepa cinerea is a slugg'sh creature. It preys on other insects found in water, mosquito larvae, dragon-fly larvae, etc., or any water animal small and weak enough to be captured by it. It sucks its prey

dry and leaves the parts useless to it. It is voracious. After one meal it remains without food for a long time before taking any more nourishment. It has been observed that in captivity the mature insect will prey on the nymphs when its suitable food is scarce. Apparently it can remain without food for a long time.

There are ten pairs of spiracles (1-10, Fig. 1) in the mature insect. Three pairs are found in the region of the thorax, six on the under surface of the abdomen, and one pair at the base of the anal siphon. All pairs are closed except the last, situated at the base of the anal siphon. The thoracic pairs, although closed, are functional. The abdominal ones are not apparently so. Out of the six abdominal ones, those on the first, the second and the last are completely closed. There is no indication of these three on the outside *i.e.*, on the surface of the body of the insect. It is only when after dissection, all the tissues have been dissolved away by potash, branches from the main tracheal trunks may be seen to come off, and are attached to spots where once spiracles existed. The positions of the other three abdominal spiracles are indicated on the ventral surface, along the lateral margin, by three large elliptically roundish spots. These are chitinous plates, with some transparent spots in them. To the edges of these round plates the closed spiracles are joined in the adult.

The Main Tracheal System.

The main tracheal system consists of two large tracheae (*a*, Fig. 1), which run the whole length of the body on either side of the middle line. Starting from the 10th spiracle, which is situated at the base of the anal siphon, each of them ends in the 1st spiracle, which is found in the prothorax. We shall call these lateral tracheal trunks. They give off branches to each spiracle. The branches to 5th, 6th, 7th and 8th each give off two or more branches to other parts of the body. When we come to the 4th spiracle a difference is noticed. Here a great number of branches are given off, forming a distinct bunch (*b*, Fig. 1). The spiracles of meso- and metathoracic segments on each side are connected by a thick trunk (*c*, Fig. 1), and do not directly communicate with the lateral tracheal trunk. This thick trunk has two (*d*, Fig. 1) branches to the lateral tracheal trunk; one just behind the mesothoracic spiracle and one at the metathoracic, so that we here get a rectangle of tracheal tubes (*a*, *c*, *d*, Fig. 1). The thick trunk on each side of the body, and just opposite the mesothoracic spiracle, gives off a branch, and these two branches meet and cross in the middle line of the body.

The spiracles will be numbered serially as they occur, from prothorax downwards to the last one, which is found at the base of the anal siphon.

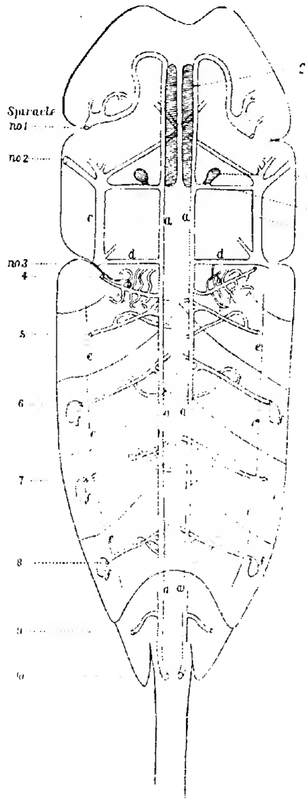


Fig. 1. The Main Tracheal System of *Nepa cinerea*.
a. Main tracheal trunk; *b*. Bunch of tracheae to the fourth spiracular branch; *c*. Thick trunk connected with the main lateral trunk; *d*. Branches connecting *c* with *a*; *e*. Chitinous ridge running parallel to the lateral margin of the abdomen; *f*. Sieve-plates; *g*. Respiratory structures of the thorax (larger); *h*. Respiratory structures of the thorax (smaller).

Spiracle No. 1. (1, Fig. 1, *a*, Fig. 2, and Fig. 3).

This spiracle is well concealed under the chitinous covering. To find it the insect must be laid on its back. On dissecting off one of

the pleura of the prothorax, or preferably shaving a good bit of the surface, the spiracle is seen to be situated on the membrane between the pro- and mesothorax. It is conical in shape, the cone enclosing a vestibule. The whole cone is membranous; the conical shape is maintained by means of chitinous supports inside the cone (*a*, Fig. 3). These, by numerous ramifications, form a network. There is no actual opening in the spiracle, but the apex is convex (*b*, Fig. 3). There is a chitinous ring round this convex apex (*c*, Fig. 3). It points

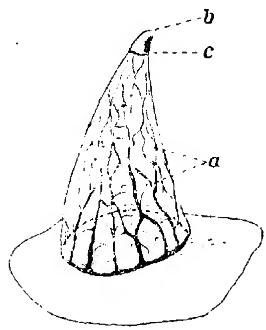


Fig. 3.

Fig. 2. Underside view of *Nepa cinerea* (adult).
a. Spiracle No. 1 (prothoracic); *b*. Sieve-plate.
Fig. 3. Side view of Spiracle No. 1 (prothoracic).
a. Chitinous supports to the conical membranous covering of the spiracle;
b. Membranous apex; *c* The chitinous ring round the apex.

downwards, *i.e.*, away from the head. As the spiracle is completely covered by the pleuron, no other protective structures are necessary. Into this spiracle three large tracheae open (No. 1, Fig. 1). One is the main lateral trunk, which starts from the anal siphon, and running through the whole length of the body, ends in this spiracle. Another trachea comes from the head, the third coming from other parts of the prothorax.

Spiracle No. 2. (No. 2, Fig. 1, *a*, Fig. 4, and Fig. 5).

This is also a well-concealed spiracle. To look for it the insect must be held by means of a pair of forceps laterally and the hemielytron dissected off. This will expose the spiracle. It will be seen as a white circular surface in the midst of a very dark brown background. It is situated, posterior to the root of the hemielytron but anterior to that of the wing, in a depression, the edge of which is formed by the elevated ridge of the pleuron of the mesothorax (*a*, Fig. 4). The depression is completely covered by the hemielytron, which thus forms

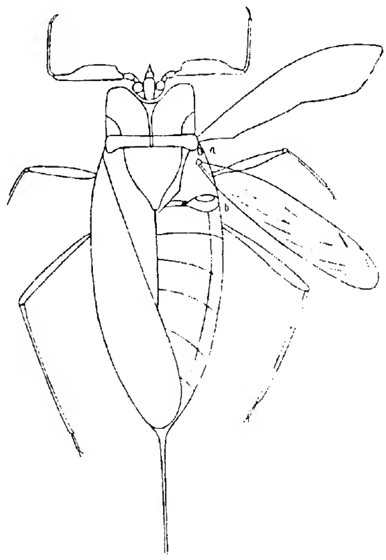


Fig. 4. Dorsal view of *Nepa cinerea* (adult).
a. Position of spiracle No. 2 (mesothoracic); *b*. Position of spiracle No. 3 (metathoracic).

a complete protection for the spiracle. The spiracle consists of an almost circular white membranous disc (*a*, Fig. 5), which forms the top of a chitinous spherical body (*b*, Fig. 5). This disc is slightly concave. There is a little chitinous spot in the centre. Inside the spiracle at this chitinous centre a muscular string is found. The use of this string appears to be to maintain the normal concave position of the membranous disc, for it can be observed under the microscope that when, under the pressure of a needle, the disc is made to bulge

out, it at once resumes its former position when the pressure is released. The surface of the disc is not smooth. Round the chitinous centre there are some loops diverging anteriorly, but they become straighter and straighter as they get posterior to the centre. There is no actual opening in the spiracle.

The tracheal connection of this spiracle is simple (No. 2, Fig. 1). It has no direct connection with the main lateral tracheal trunk. It forms the extremity of a branch coming off the anterior lateral angle of the rectangle of tracheal tubes mentioned above (*a*, *c*, *d*, Fig. 1).

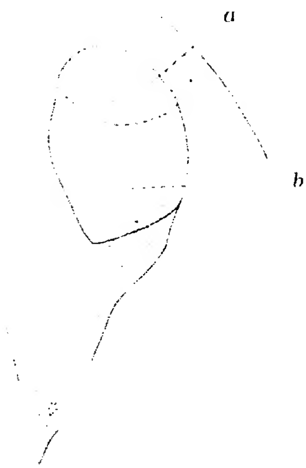


Fig. 5. External appearance of Spiracle No. 2 (mesothoracic).
a. Membranous concave covering of the spiracle; *b*. Hemispherical chitinous body of the spiracle.

Spiracle No. 3. (No. 3, Fig. 1, Fig. 6, and *b*, Fig. 4).

On dissecting off the hemielytra and the wings, the surface of the thorax and the abdomen is exposed. The background being very dark brown or sometimes reddish, and this spiracle being white it is easy to recognise it at once. It is situated behind the base of the wing, at the extreme edge of the tergum, in a narrow chitinous plate. It is oval in shape, and the longer axis lies across the body (*b*, Fig. 4).

The membranous covering of the spiracle is strongly convex (*a*, Fig. 6). In this respect it is very different from the second spiracle, in

which the membrane is normally concave. To maintain its convexity there are chitinous supports inside the spiracle (*b*, Fig. 6). These supports are so arranged that the whole spiracle, viewed from above, resembles the pattern of a crown. At the base there are triangular chitinous portions (*c*, Fig. 6). This spiracle also has no opening. It is supplied by two tracheae, one coming from the main lateral trunk

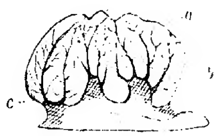


Fig. 6. Side view of Spiracle No. 3 (metathoracic).
a. Convex membranous covering of the spiracle; *b*. Chitinous supports of the membranous covering; *c* Chitinous portions of the base.

and the other which forms the outer trachea of the rectangle (No. 3, Fig. 1). This outer trachea of the parallelogram, which directly supplies spiracle 3 and gives off a large branch to spiracle 2, is larger in diameter than the main trachea, which runs from spiracle 1 back through the length of the body to the last spiracle.

The Closed Spiracles. (Nos. 4, 5, 9. Fig. 1).

I call the 4th, 5th, and the 9th pairs of spiracles the closed spiracles because they are entirely absent in the adult. But from the main lateral tracheae branches are given off in the 1st, 2nd, and 6th abdominal segments, which end against the chitin. The spots where these tracheae end are paler than the surrounding chitin, so that they are easily recognisable. The branch in the first abdominal segment, which is only represented ventrally by a small triangular sclerite on either side of the body, ends blindly on a ridge of chitin which forms the anterior boundary of the segment. The spot itself where the tracheal branch joins the sternum is small, circular (.06 mm. diameter), and transparent as seen under a high power. Near the base of this branch a great number of branches are given off, forming a bunch. These branches apparently supply air to some of the organs of the body, unless they are to be regarded as an extra air reservoir, a view which seems to gain some support from the fact that only the spiracular branch in the first abdominal segment gives off this bunch, the following spiracular branches each giving off only a pair. The spiracular branch in the 2nd abdominal segment ends on the sternum of that segment. On each of the abdominal sternites not far from the margin, is a thickened ridge which runs parallel with the margin (*e*,

Fig. 1). The spiracular branch in this 2nd abdominal segment ends inside this thickened ridge, *i.e.*, on the main portion of the sternum and about half-way between the anterior and posterior margins. It is, as in the previous case, visible externally as a pale spot. The spiracular branch in the 6th abdominal segment ends blindly in the same way as those in the 1st and 2nd, and more or less in a line with them.

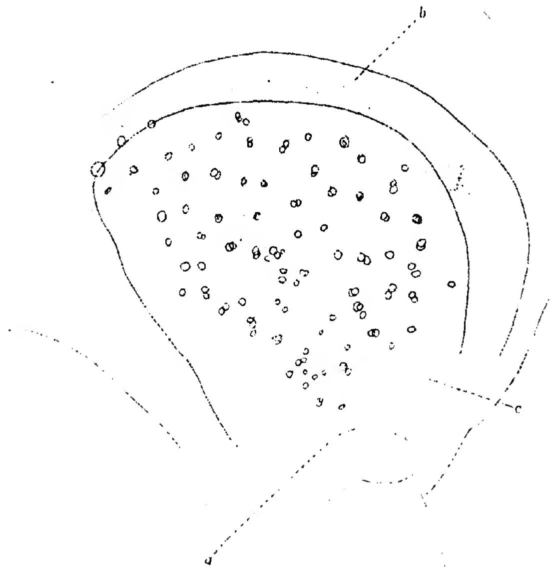


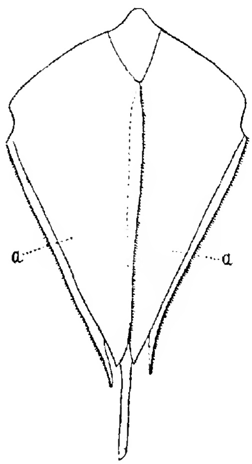
Fig. 7. Camera lucida drawing of a sieve-plate showing connection with a closed Spiracle.

a. The point where the closed spiracle joins the sieve-plate; *b*. Thickened ridge of chitin surrounding the central membranous portion; *c*. Central membranous portion with the transparent dots.

The Sieve-plate Spiracles. (*b*, Fig. 2, *f*, Fig. 1, and Fig. 7).

The 6th, 7th and 8th spiracles, *i.e.*, those in the 3rd, 4th, and 5th abdominal segments attract attention at once when the ventral side of the insect is examined. They lie in the margin between the edge of the sternum and the thickened ridge mentioned above. They are more or less oval in shape and are noticeable on account of their large size, and are surrounded by a thickened ridge of chitin (*b*, Fig. 7). These are the sieve-plates, to the edge of which the spiracles become

joined when the insect becomes adult. In the nymph these spiracles are open and are free of the sieve-plates. There are four sieve-plates in the nymph, but only three in the adult, that in the 2nd abdominal segment disappearing. In the nymph they are small, but in the adult they attain a large size. In the adult their central portion is membranous and is dotted with small spots (Fig. 7). Under a high power these spots appear to be transparent with a dark border. They run obliquely through the membrane of the sieve-plate as is shown by the fact that when examined with a high power they change their position with change of focus. They are irregularly scattered on the membrane without any definite order.



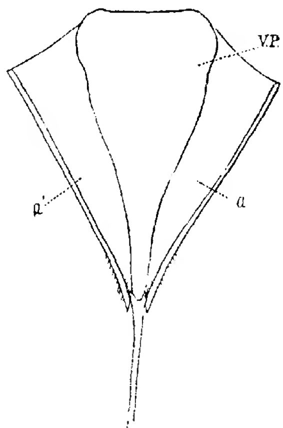


Fig. 8. Fig. 9.

Fig. 8. Dorsal view of the last segment of the Abdomen.
a. Dorsal plates of the side-pieces of the last abdominal segment.
Fig. 9. Ventral view of the same.
V.P. Ventral plate: a^1. Ventral plates of the side-pieces.

Last Segment of the Abdomen. (Figs. 8, 9, 10, and 11).

It is necessary to say something about the basal portion of the siphon which lies in the last segment. Viewed from above, the segment is triangular in shape, ventrally convex, and flat on the dorsal side. It consists of three parts, viz., a ventral triangular plate (*vp*, Fig. 9), and two side pieces, which are rather peculiar in form. Each is bent on itself, so that it has a ventral plate (*a'*, Fig. 9), and a dorsal plate (*a*, Fig. 8). The two ventral plates approach one another and

overlie the true structure. The two dorsal plates approach one another and meet in the middle line. These three plates, the two lateral and the ventral sternite, enclose a cavity in which lie the basal portions (b, b^1, Figs. 10 and 11) of the anal siphon and also the genital armature (ga, g^1a^1, Figs. 10 and 11). These three plates forming the walls of the last abdominal segment are attached to the penultimate segment, but not to one another, so that they can be spread apart the one from the other.

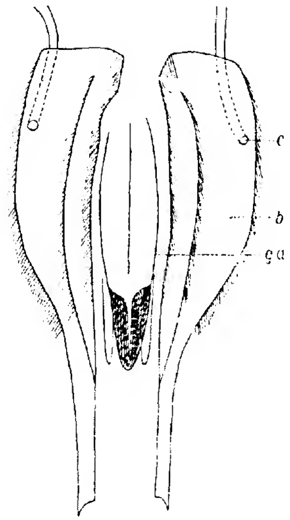


Fig. 10.

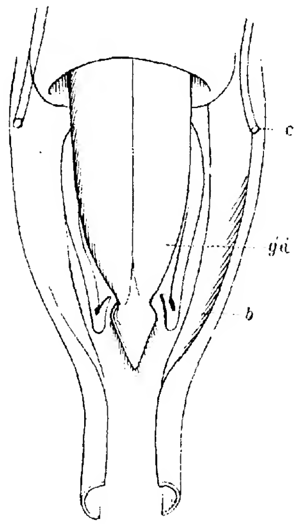


Fig. 11.

Fig. 10. Dorsal view of the base of Anal Siphon, plates a, a, of Fig. 8 removed. ga. Genital armature; b. Basal lobe of the siphon; c. Last spiracle.

Fig. 11. Ventral view of the base of Siphon, plates a^1, a^1, and V.P. removed. g^1a^1. Ventral view of the genital armature; b^1. Ventral view of the basal lobe of the siphon; c. Last spiracle.

The Anal Siphon. (Figs. 12 and 13).

The siphon is one-third the length of the whole insect. It is composed of two halves, each of which is concave towards its fellow, so that they come together to form a tube or siphon. On the edges of each concave half there are two flanges extending inwardly. In the concave surface of each half there are rather stout hairs. An enlarged view of the end of the siphon shows this character (Fig. 12). These hairs no doubt tend to prevent foreign particles from passing down the

siphon. A short distance from the base of the siphon the surface is densely covered with hairs. The direction of these hairs is from the base to the apex. Before emerging from the last segment, at the point where the two concave halves of the siphon meet, the siphon appears to be constricted (*d*, Fig. 13). This "constricted" portion of the tube is transversely striated, bands of dark and light colours alternating, but there are apparently no ridges. This may be a spring-like portion to allow of the siphon bending without breaking. In the last segment of the body the two basal ends enclose the sexual armature which lies ventrally between them.

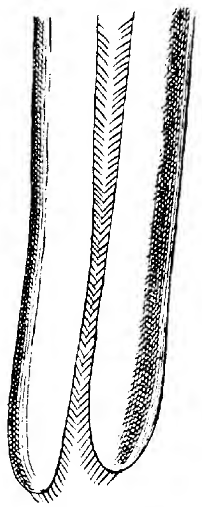


Fig. 12. Camera lucida drawing of the Apical end of the Anal Siphon (enlarged).

The Last Spiracle. (*c*, Figs. 10, 11, 13).

The lateral tracheal trunks run out one into the base of each half of the siphon and open on its ventral face and on the outward side. The opening of the spiracle is, therefore, found at the middle of the basal lobe of the siphon on its outward lateral edge. It opens in the chitinous wall. The opening is simple and without any membranous covering. It is circular, having a diameter of about .1 mm. A dense covering of rather long hairs forms the protection of this spiracle. It will be noticed that the spiracle opens at a point which is at some distance from the place where the siphon is actually formed by the

opposition of the two halves. The atmospheric air coming down the tube, in order to reach the spiracle, must traverse this distance by passing the hairs.

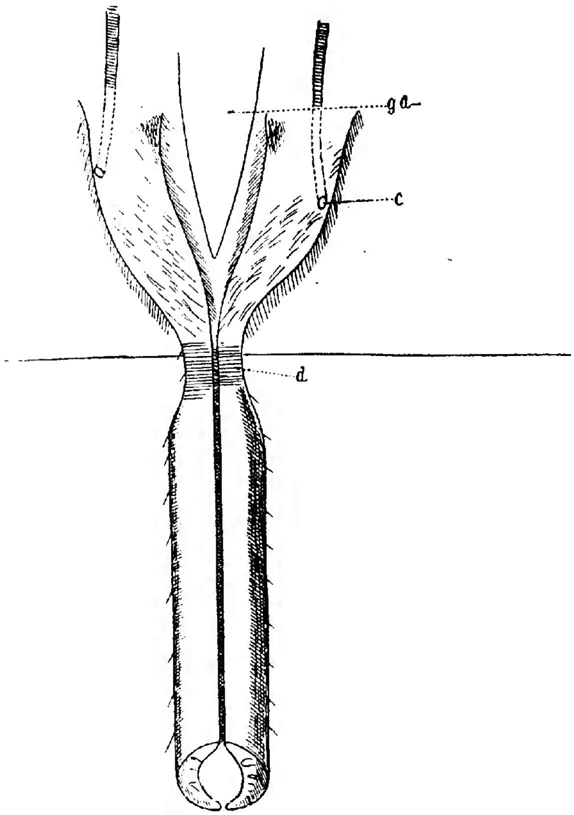


Fig. 13. Anal Siphon with its tip cut off.
d. The so-called constricted portion; *c*. The last spiracle; *ga*. Genital armature.
Above the line the structures are inside the body, below the line they are outside.

Respiratory Structure in the Thorax. (*g*, *h*, Fig. 1, and Figs. 14, 15, 16).

There are two large and two small structures in the thorax. In the mesothorax there is another small pair situated ventrally. The larger structures lie in the middle of the thorax just under and closely

applied to the scutellum. They are as long as the whole scutellum. Each of these structures consists of a bundle of connective tissue fibres. This bundle is attached to the main tracheal trunk on its inner side by means of numerous small tracheae which ramify into the fibres. In specimens treated with potash the greater portion of these fibres is dissolved away. In potashed specimens the smaller tracheae that branch off the main trachea into the fibres can be clearly seen (Fig. 15). These smaller tracheae again branch and ramify into the fibres. This fact is shown in Fig. 16. Figure 16 is a transverse section through

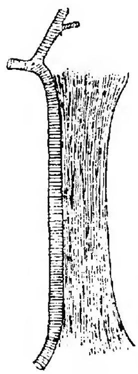


Fig. 14.

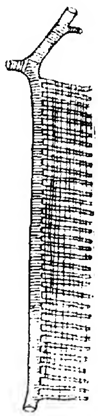


Fig. 15.

Fig. 16.

Fig. 14. Respiratory Structures in the Thorax, under the Scutellum (unpotashed specimen).

Fig. 15. The same specimen after soaking in potash. The figure is diagrammatic.

Fig. 16. Micrograph of a transverse section through the Respiratory Structure under the Scutellum.

the respiratory structure under the scutellum. It shows the numerous ramifications of the small tracheae that branch off the main tracheal trunk. The black dots are the sections through the fibres. The smaller structures lie on the outer side of the main tracheal trunk (*b*, Fig. 1). These respiratory structures are absent in the nymph.

Breathing.

The adult insect breathes the atmospheric air. The air is ordinarily taken in by the anal siphon and through the siphonal spiracles it enters the main tracheal trunks and its branches. The insect also keeps a supply of air under the wings and in the concavity

of the mesothoracic pleuron. From the structure of respiratory system and spiracles it can be concluded that it is a closed system of tubes with numerous ramifications with only two openings. These two openings are the last pair of spiracles, situated at the base of the anal siphon. Of the rest of the system in the adult, only three small membranous surfaces—spiracles 1, 2, and 3, can be in contact with the air. Under these given circumstances one inference is possible—the respiration is carried on by the diffusion of gases through the membranous covering of the thoracic spiracles.

There are three states in which its respiration can be conceived :—

(1) When the insect is completely submerged.

The air which has been once taken in by the siphon is being gradually used up and CO_2 diffuses out of the thoracic spiracles. As the insect can remain submerged for a long time, the film of air under the wings in the cavity of the mesothoracic pleuron supplies the oxygen which diffuses in through the meso- and metathoracic spiracles. The first pair of spiracles only serve for exhalation in this case, because no fresh air can diffuse in because, being situated ventrally, it is not in contact with air.

(2) When the anal siphon is in contact with the atmosphere. In this case the air is inhaled by the anal siphon, and the interchange of CO_2 and O_2 takes place through the thoracic spiracles.

(3) When the insect is out of water all the thoracic spiracles are used both for exhaling and inhaling. The anal siphon is not necessary as an inhaling organ.

Nymph or Immature Form.

In the nymph (Fig. 17) there are ten pairs of spiracles as in the adult, and in similar positions, except No. 3, which has become completely dorsal in the adult. All the spiracles are open. The siphon of the adult is absent in the nymph. But we find a concave projection (*a*, Fig. 17) from the abdomen instead. On either side of the ventral surface there is a flap of tissue (*b*, Fig. 17) formed by an overlap of the tergum of each segment. The edge of this flap is covered with thick hairs and the flap overlies a shallow groove (*c*, Fig. 17) in which all the abdominal spiracles open. Although this flap forms one whole piece, four distinct sections are recognisable. The inner edge of each section is unequally divided into two convex portions. In the middle of each division there is a small circular chitinous plate (*d*, Fig 17), which overlies a spiracle. This small circular plate is the rudiment of the sieve-plate of the adult. As has been already mentioned, there are four of them in the nymph but only three in the adult. The inner

edge of the flap has thus a scolloped appearance. The midventral region (*e*, Fig. 17) of the abdomen is raised, and from the edges of the raised portion long hairs extend outwardly towards the flap, the hairs on the edge of which they mingle with. Thus a felt coating is formed over the groove. This shallow abdominal groove is continued into the thorax to supply air to the thoracic spiracles. At the junction of the thorax and the abdomen, where the felt covering of hairs is wanting, the groove is covered by a large pleuron (*f*, Fig. 17).

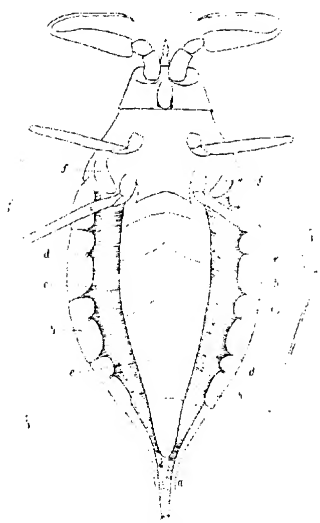


Fig. 17. Ventral view of the Nymph.
a. The concave abdominal projection; *b*. The lateral flap; *c*. The shallow groove. *d*. Small circular chitinous plates; *e*. The midventral raised portion of the abdomen. *f*. The pleuron protecting the groove proceeding into the thorax.

The tracheal system is similar in its general scheme as that of the adult. The thoracic respiratory structures found in the adult are absent in the nymph. In the nymph the spiracles are small, but in the adult they attain great dimensions. This points to the conclusion that in the adult the thoracic spiracles play a great part in the respiration.

Breathing.

The nymph always breathes the atmospheric air. In the concave abdominal projection and in the two shallow grooves on either side of the raised midventral region of the abdomen of the nymph there is

always a layer of air. The covering of hairs ensures the retention of this layer. The nymph prefers to remain always in communication with the atmosphere by putting the abdominal projection out of the surface of water. If it has to go down below the surface, it comes up quickly. All its activities, therefore, are confined to a few inches under the surface. If the nymph is artificially prevented from getting access to the atmosphere, it soon falls into a comatose condition, from which it can recover when it is allowed access to the atmosphere again. But if the artificial restriction continues, it dies within a few minutes.

From these facts I conclude that atmospheric air is essential for the respiration of the nymph. The open spiracles, the abdominal projection, the marginal flaps of the abdomen, the shallow grooves, the thick covering of hairs on the grooves, the continuation of the grooves into the thorax with a protective covering of a pleuron—all these are functional during the respiration of the insect.

As to the question about the cause of the modifications in the adult, I suggest the following :—It is obvious that the change takes place in one stage of life of the insect which differs from other stages, in that it acquires the function of reproduction. It is probable, therefore, that the exigencies of reproduction may require its prolonged submersion under water. A second reason is that of hibernation and of withstanding the weather in winter, when it may have to remain under a layer of ice. For these two reasons it is considered probable that the adult insect is provided with special organs in connection with its respiratory system which are absent in the nymph.

TABULATED CONCLUSIONS.

LARVA.	ADULT.
Ten pairs of spiracles.	Ten pairs of spiracles.
All spiracles open and functional.	One pair open and the rest closed. Thoracic pairs and the siphonal pair functional.
No anal siphon, but a short concave projection.	A long anal siphon.
All spiracles ventral.	Spiracles Nos. 2 and 3 have become dorsal.
No respiratory structures in the thorax.	They are present in the adult.

I am indebted to Mr. Balfour-Browne for criticisms and suggestions.

Since the present enquiry was completed a paper on the same subject was brought to my notice by Mr. Balfour-Browne (Dogs, Mitt. Nat. Ver. Greifswald, 1909). It will therefore be necessary to show the correlation of the present paper with that of Dogs', although the conclusions arrived at here are the result of independent investigation. To show this correlation I propose to compare his conclusions with my own.

His conclusions are (translated from the German, *l.c.*, p. 50):—

(1) The abdominal shovel of the larva is short and grooved. The breathing tube of the imago is distinctly longer and double.

(2) In the larva all the stigmatas are open, in the imago only the thoracic and the first (metathoracic) and last abdominal stigmatas are open; the rest are closed.

(3) The stigmatas of the larva lie in the breathing groove which extends through the pleurite into the mesothorax; in the imago the respiratory groove is wanting, and the pleurites are distinctly shorter.

(4) The fourth, fifth and sixth abdominal pairs of stigmatas are in the imago modified as sense organs.

(5) The first abdominal (metathoracic) pair of stigmatas in the larva is situated ventrally; in the imago this pair is situated dorsally.

(6) The mesothoracic (prothoracic) stigmata of the larva is small and indistinct; in the imago it is considerably enlarged.

(7) In the imago we find tracheal lungs and tracheal sacs; these are wanting in the larva.

Comparing these conclusions with those of mine, the following points call for notice:—

(*a*) In naming the spiracles, Dogs has not given a definite decision. As I have already said, there are three pairs of spiracles in the thoracic region, and the abdominal series commences with a completely closed spiracle which I have called the fourth. The first three spiracles occurring in the thoracic region should be called pro- meso- meta-thoracic spiracles respectively. The spiracles which he calls mesothoracic and first abdominal are, therefore, prothoracic and metathoracic respectively. Although the naming of the spiracles is not very important to the present investigation, yet, in order to avoid confusion, the plan I have adopted, of numbering them serially as they occur from prothorax to the base of the anal siphon is most satisfactory.

(*b*) Dogs, in his conclusion No. 2, says that the thoracic and last abdominal stigmatas of the imago are *open*. I do not agree with him when he says that the thoracic pairs of the imago are *open*. They are

functional, but they are not open. My figures show their real structure. I have pointed out this fact in my descriptions of these spiracles. The spiracle at the base of the anal siphon is really open, and this is the only open spiracle in the imago. All the spiracles in the nymph are open and functional.

(*c*) As regards the point that the sieve-plate spiracles become sense organs in the adult, Dogs is not quite sure himself. After discussing the point he leaves the question open. The evidence on which he bases his conclusion is that he found nerve cords running into the sieve-plates. I cannot confirm him in this observation, as all his subsequent experiments failed to produce any result in support of this finding, much reliance cannot be placed on it (p. 35).

(*d*) Lastly, Dogs calls the respiratory structures in the thorax "lungs" and "sacs." I do not agree that they are sacs, because my micrographs (Fig. 15) of the transverse sections through these structures prove conclusively that their structure is not that of a sac. They are no doubt respiratory in function, but in structure they are a bundle of minute tubes.

In other findings—excepting the above where I have disagreed—I can confirm him.

With regard to the figures, mine are complementary to his because mine show more of the structures of the adult, while his depict those of the nymph.

There exists another paper, entitled "Statische Sinnesorgane bei den Nepiden," by Walther Baunacke. The work was done at the University of Greifswald, and published in *Zoologische Jahrbücher*, Jena, 1912, pp. 179-346. The object of this elaborate paper being different, I do not enter into a discussion of its conclusions here.

The references given in these two papers will be sufficient for future workers. Hence I do not give a separate list of papers consulted by me here.

NOTES ON PARASITIC ACARI.

A. ON SOME SPECIES OF ACARI PARASITIC ON MAMMALS AND BIRDS IN GREAT BRITAIN.

B. DESCRIPTIONS OF TWO NEW AFRICAN MITES OF THE FAMILY GAMASIDAE.

By STANLEY HIRST.

(Published by permission of the Trustees of the British Museum).

WITH 14 TEXT-FIGURES.

A.—ON SOME SPECIES OF ACARI PARASITIC ON MAMMALS AND BIRDS IN GREAT BRITAIN.

The present note deals with mites of the families Gamasidae and Ixodidae. Some of the specimens listed below were presented to the British Museum by the Hon. N. Charles Rothschild; others were lent me for examination by the Rev. James Waterston. The specimens from the Island of Lewis were collected by Lieut. G. Bathurst Hony. My best thanks are due to these gentlemen for the opportunity of working out this material. Although the number of species dealt with is small, several of them are new to the British Fauna, including both the species of *Myonyssus* and two species of *Laelaps* (*L. festinus* and *L. pachypus*).

FAMILY GAMASIDAE.

Genus **Haemogamasus**, Berl.

Key to the species of **Haemogamasus** (females).

1	Sternal plate with numerous hairs - - -	2
	Sternal plate with only three pairs of hairs - -	3
2	Hairs on legs and body plain -	*H. hirsutus*, Berlese.
	Hairs on legs strongly feathered, hairs on body usually with a few accessory plumules at base.	*H. liberiensis*, n.sp.
3	Sternal plate very strongly concave posteriorly; hairs on body comparatively sparse -	*H. oudemansi*, Hirst.
	Sternal plate trapezoidal in shape, at most only slightly concave posteriorily; hairs on body very numerous and set close together - - -	4

[JOURN. ZOOL. RESEARCH, June, 1916, vol. i, No. 2.]

4 Genito-ventral plate rather wide, its sides strongly convex; hairs on anal plate few in number - - - - *H. nidi*, Michael.
Genito-ventral plate smaller, its sides not so strongly convex; hairs on anal plate usually more numerous - - - *H. horridus*, Michael.

Two North American species of *Haemogamasus* (*H. americanus*, Banks, and *H. sanguineus*, Ewing) have been described so briefly that I cannot include them in the above key. According to Banks' description, *H. americanus* has the fourth tarsus but little longer than the first, thus differing from my new African species. The other American species (*H. sanguineus*) appears to be chiefly characterised by having the body only sparsely clothed with hairs. It is quite probable that it really belongs to another genus (*Liponyssus*). Ewing's *Liponyssus spiniger* (from the Musk rat) described in the same paper, probably is *Laelaps multispinosus*, Banks.

Haemogamasus nidi, Michael.

Loc.—Yorkshire, 2-iii-1912; specimens captured by B. Brian on *Mustela nivalis* (ex Hon. N. C. Rothschild's Coll.). Gullane, Haddington, Scotland, 4-vi-1911; specimens found by E. W. Cormack in a mole's nest (Waterston Coll.). Island of Lewis, Outer Hebrides; specimens taken by G. Bathurst Hony on field mice, *Apodemus hebridensis* (6-14-vii, 1914), and on rat (3-vii-1914). Ollaberry, Shetland Islands; specimens found by the Rev. James Waterston in the nest of a house mouse (*Mus musculus*), 1-v-1911. Kingsland, Ollaberry, 23-i-1912; specimens from the nest of *Apodemus sylvaticus* (Waterston Coll.). Arran, Scotland, 1912; a female specimen found by R. W. Sheppard on a field vole; ex Hon. N. C. Rothschild's Coll. Islay, Scotland, 1912, specimens found by R. W. Sheppard on a field vole; ex Hon. N. C. Rothschild's Coll. Harrow, Middlesex, 16-vi-1915; specimens found on *Epimys norvegicus* (H. E. Box). Taucha, near Leipzig, Germany; v-1910, specimens found by O. Fritsche on *Talpa europaea* (ex Hon. N. C. Rothschild's Coll.).

Haemogamasus horridus, Michael.

Loc.—Island of Lewis, Outer Hebrides; 15-vii-1914, a female example found by G. Bathurst Hony on a field mouse (*Apodemus hebridensis*). Kingsland, Ollaberry, Shetland Islands, 22-i-1912; a male and a female from nest of *Apodemus sylvaticus* (Waterston Coll.).

There are fourteen hairs on the anal plate of the specimen from the Island of Lewis, and they are arranged practically as depicted in

Michael's figure (Trans. Linn. Soc. Zool., 1892 (2), v, pl. 32, fig. 2). The female from the Shetland Islands has only nine hairs on its anal plate. Probably these differences are only individual and not of systematic value.

Haemogamasus hirsutus, Berlese.

Loc.—Boxworth, Cambridge; specimens collected by E. H. Thornhill on *Talpa europaea*, v-1911 (ex Hon. N. C. Rothschild's Coll.). Harrow, Middlesex, 16-vi-1915, a female specimen found on *Epimys norvegicus* (H. E. Box). East Lothian, 14-iii-1908; specimens found in mole's nest (W. Evans).

Haemogamasus oudemansi, Hirst.

Loc.—This species was described from English specimens found on the brown rat (see Bull. Ent. Res., 1914, v, pp. 122 and 123, pls. 14-16). Evidently it is a widely distributed species, for I have since examined a female specimen found on a Bat in South Africa (Peringuey Coll.). Unfortunately the exact locality and host of this specimen is not given.

Genus Dermanyssus, Dugès.

The species of the genus *Dermanyssus* are few in number, only five or six valid forms being known. Three of these are parasitic on rodents, the others on birds. As in the genus *Liponyssus* (= *Ichoronyssus*), there may be either a single undivided dorsal shield (scutum) or two separate shields, the posterior shield in the latter case being very small. The two species (*D. aegyptius* and *D. sanguineus*) which have two dorsal shields also differ from the other species of the genus in having the anal plate oval instead of heart-shaped, but the chelicerae of the female are very elongate and quite typical for the genus (see Fig. 1). The females of the species of *Dermanyssus* can easily be distinguished from one another by the following key:—

Key to the species of the Genus **Dermanyssus** (females).

1	Two dorsal shields present, the posterior one being minute. Anal plate oval - - - -	2
	A single undivided dorsal scutum. Anal plate heart-shaped - - - - - -	3
2	Minute posterior dorsal shield oval and bearing a pair of hairs. Three pairs of hairs on sternal plate. (Parasitic on rodents) -	*D. sanguineus*, Hirst.
	Minute posterior dorsal shield alate and without hairs. Only two pairs of hairs on sternal plate. (Parasitic on rodents) -	*D. aegyptius*, Hirst.

3. Posterior end of dorsal scutum rounded (*fide* Berlese). (Parasitic on the common sparrow) *D. passerinus*, Berl. and Trouess.
   Posterior end of scutum truncated - - - 4

4. Genito-ventral plate wide. Hairs on dorsal scutum short. (Parasitic on the domestic fowl and other birds) - - - *D. gallinae*, Redi.
   Genito-ventral plate rather narrow posteriorly. Hairs on scutum and rest of the dorsal surface long. (Parasitic on *Epimys rattus*) *D. muris*, Hirst.

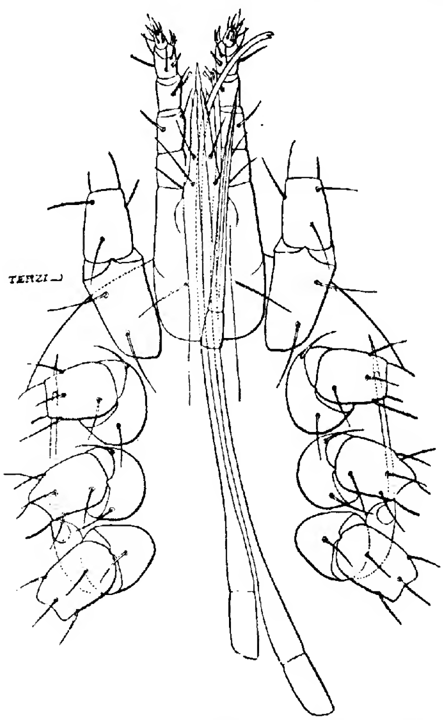


Fig. 1. *Dermanyssus aegyptius*, Hirst, female, ventral view of anterior part of body showing the chelicerae in situ.

Dermanyssus gallinae, Redi.

In addition to specimens from fowls, I have seen others of this species from the following hosts and localities:—Dirleton, Haddington,

Scotland, 2-ix-1909, from swallow's nest (*Hirundo rustica*); specimens collected by the Rev. James Waterston. Loudoun Estate, Ayrshire, Scotland, ix-1909, from swallow's nest (*H. rustica*); specimens collected by J. Gloag (Waterston Coll.). In a cave, Fast Castle Rock, St. Abbs Head, 6-ix-1909; numerous specimens found by Rev. James Waterston in the nest of a wild pigeon (*C. livia*). Near St. Abbs, Coldingham, Berwickshire, Scotland, 25-viii-1909 and 6-ix-1909, from house martins' nest (*Chelidon urbica*); Waterston Coll. From caged chaffinches at the Lister Institute, London, S.W., v-1913 (Dr. H. M. Woodcock). From nest of sparrow (*Passer domesticus*), found on the roof of the Natural History Museum, South Kensington, 11-v-1915 (S. Hirst). Gospic, Croatia, 1910, specimens found by F. Dobiatsch on an eagle owl (*Bubo maximus*); specimens presented to the Museum by the Hon. N. Charles Rothschild. Tangier, Morocco; a female example from *Gecinus vaillantii* (Waterston, Coll.).

I have carefully examined the specimens listed above and cannot find any real differences in structure between them. Examples from the nests of swallows and sparrows have the dorsal scutum shaped exactly as in those from domestic fowls, the posterior end being always truncated, and the distribution of the hairs on the scutum is also the same. The size of this species is very variable even in adult examples from the same locality. Length of peritreme also rather variable, but it is usually long even in specimens from swallows. The first leg is the longest, being about equal to the length of the dorsal scutum, although it may be a little shorter than it or slightly longer. It is probable that Hermann's *Acarus hirundinis* and also *Dermanyssus longipes*, Berl. and Trouess (from the sparrow) are synonyms of *D. gallinae*.

Dermanyssus muris, Hirst.

Additional locality.—Hoshangabad, Central India, 1912. A single protonymph from *Epimys rattus*, collected by C. A. Crump, and presented to the British Museum by the Hon. N. Charles Rothschild.

The protonymph of this species can easily be recognised by the shape of the minute posterior scutum on the dorsal surface.

Genus **Myonyssus**, Tir.

The first species of this genus was described by Dr. C. Tiraboschi in 1904, under the name *M. decumani* in his well-known paper entitled "Les Rats, les Souris, et leurs parasites cutanés, dans leurs rapports avec la propagation de la peste bubonique" (Arch. parasit., viii, pp. 337, 338, fig. 68. His description is based on a single female example found at Rome on a sewer rat (*Mus decumanus* = *Epimys norvegicus*). A second species of *Myonyssus* has been recently

described by the celebrated Dutch parasitologist, Dr. A. C. Oudemans, of Arnhem, under the name *Liponyssus gigas*. Both these species of *Myonyssus* occur in Scotland, and I take the opportunity to point out the principal differences between them.

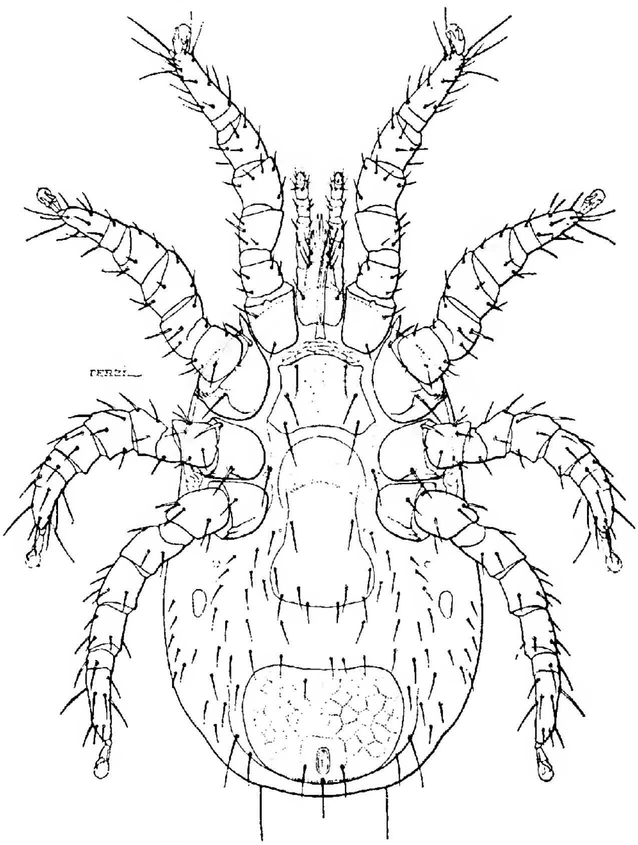


Fig. 2. *Myonyssus decumani*, Tir., ventral view of female.

Myonyssus decumani, Tir.

Figs. 2 and 3.

♀ *Dorsal scutum* finely reticulated, but without any trace of ridges. *Genito-ventral plate* much smaller than that of *M. gigas*, and only furnished with ten hairs (twelve according to Tiraboschi's figure).

Anal plate not so wide as that of *M. gigas*, but its length greater as compared with the width; besides the three hairs near the anal aperture there is sometimes a little hair (occasionally two?) situated near the middle of the anterior border. Processes of hypostome shorter than in *M. gigas*.

Length of body 1.2 mm.; its width .65 mm.

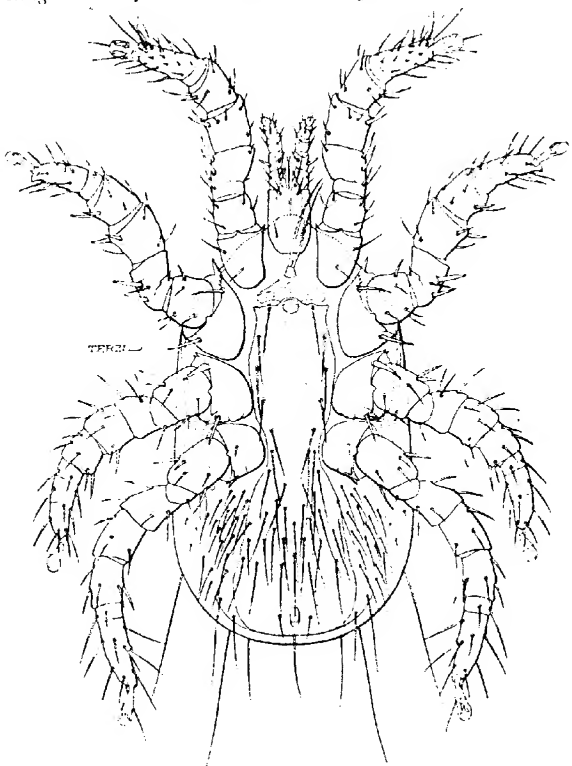


Fig. 3. *Myonyssus decumani*, Tir., ventral view of male.

♂ Hairs on *dorsal scutum* mostly minute and inconspicuous, but there are some long hairs at the sides and also at the hinder end of the body, two pairs of these posterior hairs being specially long and noticeable. As in the female, a little rounded eye-like structure is present on each side of the scutum near its hinder end, in the same position as in *M. gigas*. *Genito-ventral plate* shaped as shown in

figure, the hairs on the posterior part of its surface are numerous and very long and slender, the distal half of these hairs being very fine. Hairs on rest of venter also long and fine.

Length of body .9 mm.; its width .52 mm.

Loc.—Ollaberry, Shetland Islands; a large number of specimens found on the house mouse and in its nest, 15-iii-1912 and 1-v-1911 (Waterston).

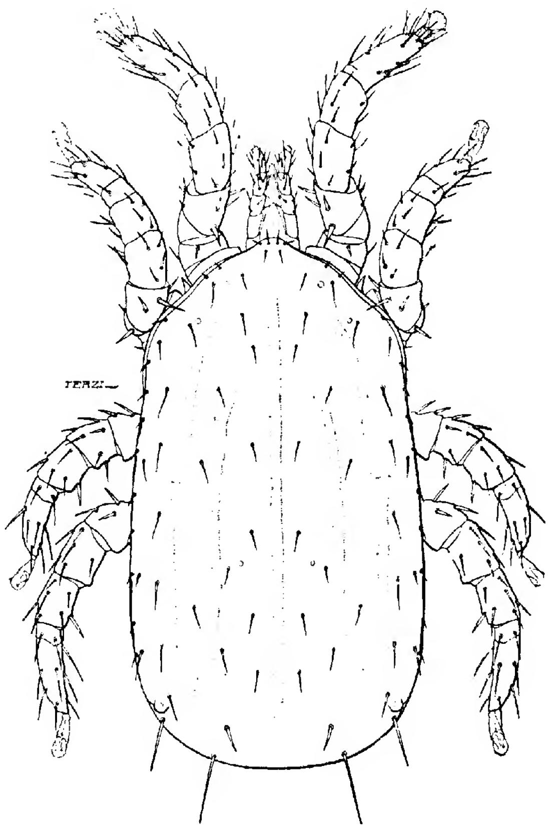


Fig. 4. *Myonyssus gigas*, Oudms., dorsal view of female.

Myonyssus gigas, Oudemans.

Fig. 4.

Liponyssus gigas, Oudms., Ber. Ned. Ent. Ver., 1912, vol. 3, p. 231; Oudms., Tijdschr. Ent., 1912, vol. 55, verslagen, p. li; Oudms., Arch. Naturg., 1913, vol. 79, Abt. A, heft. 9, pp. 84-91, text figs., 303-317.

♀ *Dorsal scutum* ornamented with smooth, raised ridges, viz., a central continuous ridge and a pair on each side of it, these lateral ridges being interrupted in the middle. Surface of the scutum between these ridges sculptured with reticulate, linear, scale-like markings. *Genito-ventral plate* large, wide and bearing about twenty hairs. *Anal plate* half-moon shaped, but wider and shorter than that of *M. decumani*, Tir.

Loc.—Howletburn, Galston District, Ayrshire, Scotland, 30-i-1911; two female specimens found by J. Gloag on *Talpa europaea*, and another female specimen from the same locality found on *Apodemus sylvaticus*, 30-ix-1910 (Waterston Coll.). Also a micro-preparation of female specimens from the nest of *T. europaea*, taken by F. Heselhaus at Sittard (Ex. Oudeman's Coll.).

Genus **Laelaps**, C. L. Koch.

Key to the British species of **Laelaps** (females), found on mammals.

1 { Hairs on dorsal scutum and sternal plate mostly short and spiniform or subspiniform - - 2
Hairs on dorsal scutum and sternal plate finer - - 3

2 { Sternal plate trapezoidal, anterior pairs of hairs on it rather short and subspiniform *L. agilis*, C. L. Koch.
Sternal plate strongly concave posteriorly; anterior pair of hairs on it long and more slender than the others - - - *L. pachypus*, C. L. Koch.

3 { Sternal plate about as wide as long; posterior part of genito-ventral plate very wide *L. echidninus*, Berlese.
Sternal plate considerably wider than long - - 4

4 { Genito-ventral plate divided into segments by transverse linear markings. Paired spines on anal plate well developed - *L. hilaris*, C. L. Koch.
Hinder part of genito-ventral plate wider as compared with its length, and without any very distinct linear markings. Paired spines on anal plate very short - - *L. festinus*, C. L. Koch.

Laelaps agilis, C. L. Koch.

Laelaps arvolica, C. L. George, Science Gossip, 1889, vol. xxv, pp. 6 and 7, two text figs

Loc.—Northwood, Middlesex, on water rat, x-1913 (*Arvicola amphibius*), S. Hirst. Abbey St. Bathaus, Berwickshire, on a water rat (J. Lawson). Grundberg, Germany, on young *Arvicola* sp. 9-vii-1910, and on *Talpa europaea* (R. E. Hoffmann, ex Hon. N. C.

Rothschild's Coll.). Taucha, near Leipsig, on *Arvicola terrestris*, 9-iii-1910, and on *Talpa europaea*, 27-xi-1913 (O. Fritsche, ex Hon. N. C. Rothschild's Coll.). Rosenheim, Bavaria (Host not given), 4-iv-1913 (E. Oeller) (ex Hon. N. C. Rothschild's Coll.).

Dr. C. L. George redescribed this species again as new in 1889. His specimens were found by Mr. J. E. Mason on the usual host, a water rat (*Arvicola amphibius*) at Alford, Lincolnshire.

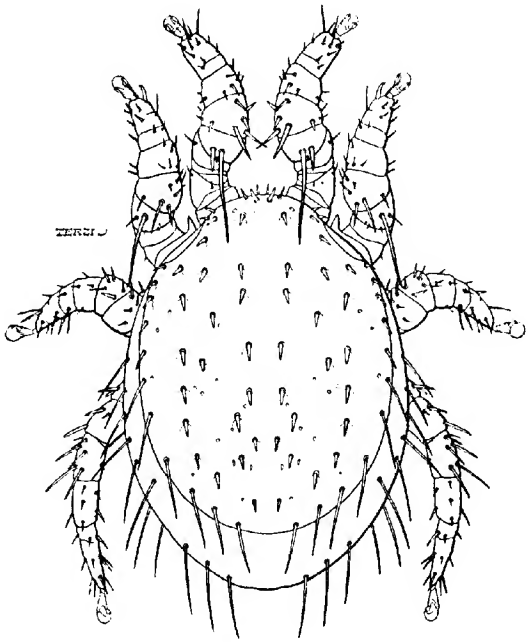


Fig. 5 *Laelaps pachypus*, C. L. Koch, female, dorsal aspect.

Laelaps pachypus, C. L. Koch.

Fig. 5 and 6.

♀ *Body* rather short oval; *scutum* shaped as in figure, being fairly widely rounded off posteriorily; it covers nearly all the dorsal surface, but usually leaves part of the hinder end of the body unprotected. Spines on scutum very short and rather stout, as in the North American species *L. multispinosus*, Banks; besides these spinules, there is a row of comparatively long and slender setae

arranged along the hinder margin of the scutum. *Sternal plate* strong concave posteriorly, being rather short in the middle, but with the sides well developed and projecting backwards; anterior pair of hairs on this plate long and setiform, instead of short as in *L. agilis*, the others short and stout. *Genito-ventral plate* fairly wide, and marked with transverse lines resembling those present on that of *L. hilaris*, C. L. Koch, but rather more irregular in arrangement; first pair of hairs on this plate replaced by short, stout spines, the others

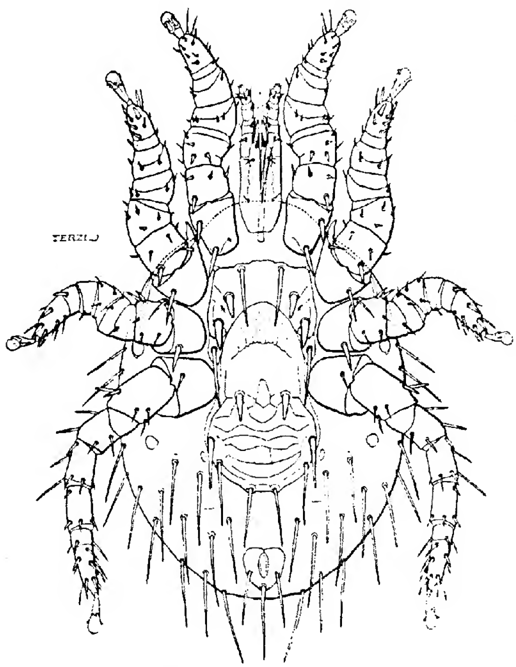


Fig. 6 *Laelaps pachypus*, C. L. Koch, ventral view of female.

are longer and setiform, but fairly thick. *Anal plate* with the paired spines well developed (they are unusually long in the specimens from the Orkney Islands). *Legs*, 1-3 short, the first two pairs being very stout; legs of fourth pair much longer and not so thick. Hairs on ventral surface of capitulum and on proximal segments of first leg shorter and more spiniform than in *L. agilis*. There are several strong spines and setae on dorsal surface of femur and patella of first and

second legs, one on the femora being especially long. Some short, stout spines are also present on the second and third tarsi. Fourth tarsus with the setae not very long and only moderately stout.

Length of body .67 mm.; its width .5 mm.

Loc.—Northwood, Middlesex, from water rat, *Arvicola amphibius*, x-1913 (S. Hirst). Orkney Islands, several specimens found by Rev. R. Godfrey on *Microtus orcadensis* (Waterston Coll.). Grundberg, Germany, a few specimens from a young *Arvicola*, 9-vii-1910; presented to the British Museum by the Hon. N. C. Rothschild.

Laelaps hilaris, C. L. Koch.

Loc.—Orkney Islands; several female specimens from *Microtus orcadensis* and two from a house mouse (collected by Rev. R. Godfrey, now in Waterston's Collection). Cumbrae, Scotland, 1912, a female specimen found by R. W. Sheppard on a wood mouse (ex Hon. N. C. Rothschild's Coll.). Islay, Scotland, 1912, a female specimen, found by R. W. Sheppard on a field vole (ex Hon. N. C. Rothschild's Coll.). Kinneff, Kincardineshire, Scotland, specimens found on a weasel or stoat (Waterston Coll.). There is also a mounted female of this species (micro-preparation) from *Microtus arvalis*, Sneek, Holland, 20-v-1895, in our collection (Ex Oudeman's Coll.).

Laelaps festinus, C. L. Koch.

Figs. 7–9.

♀ Shape of *body*, short oval, very like *L. agilis*, C. L. Koch, but slightly narrower and more deeply emarginate at the sides anteriorly. Dorsal *scutum* not quite so widely rounded at the posterior end as in *L. agilis*; hairs on its surface fairly numerous, slender, and not long, but there is a pair of somewhat longer hairs on the margin at the hinder end and a pair of exceptionally minute hairs just in front of them. *Sternal plate* strongly chitinous and trapezoidal in shape, being considerably wider than long; the three pairs of hairs on its surface long and rather slender. Posterior part of *genito-ventral plate* much wider as compared with the length than is the case in *L. hilaris*, C. L. Koch, and quite different in shape; moreover, the lines on its surface are very faint and inconspicuous, instead of distinct as in that species; the four pairs of hairs on this plate are long and rather slender. *Anal plate* rather large, the paired hairs on it minute, being much shorter as compared with the length of the posterior unpaired hair than in *L. hilaris*. The little lateral platelet is wide and oval in outline, as in *L. hilaris*. Setae on venter of moderate length and thickness, those at the hinder end being the longest. *Legs* rather

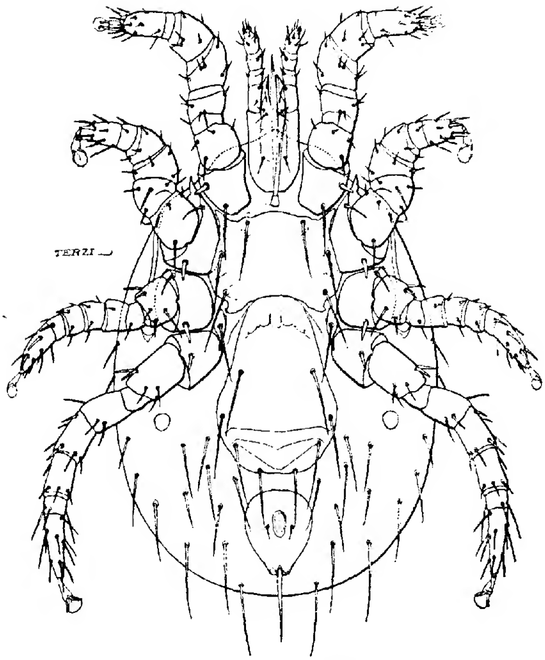


Fig. 7. *Laelaps festinus*, C. L. Koch, female, ventral aspect.

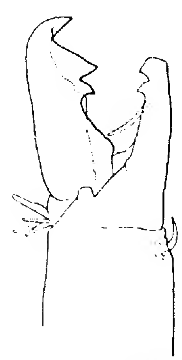


Fig. 8. *Laelaps festinus*, C. L. Koch, chelicera of female from the side.

short, those of the fourth pair being longer than the others; first two pairs of legs stout. Hairs on legs mostly short; some of those on the second and third tarsi are stout; spines on fourth tarsus only of moderate length; there are two very long setae on the dorsal surface of the first femur, the inner one of the two being shorter than the other. Second femur with two moderately long setae, and a spiniform

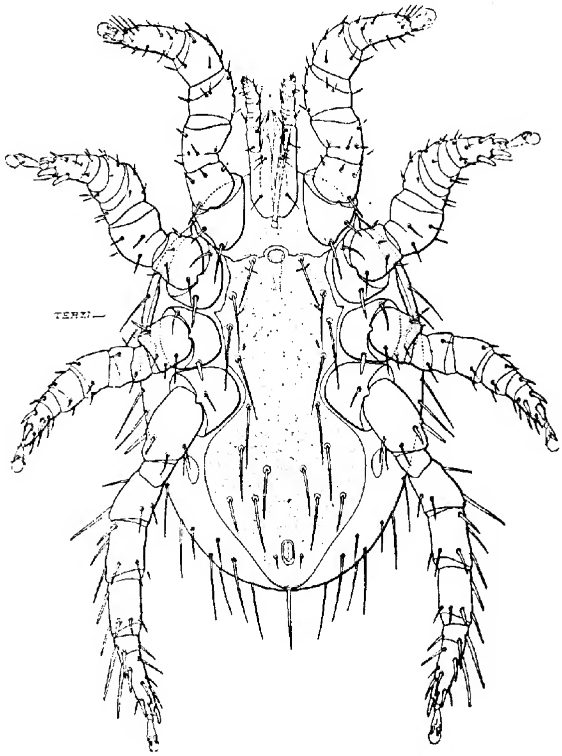


Fig. 9. *Laelaps festinus*, C. L. Koch, ventral view of male.

seta is present on the femur of the fourth leg. Coxae furnished with the usual thorns.

Chelicera (Fig. 8). Immovable finger rather weak and almost straight; it has two little teeth at its distal extremity, and there is a rather short seta close behind them. Movable finger stout and well developed; it is furnished with a large bifid tooth, and the distal end

is also turned up and tooth-like. Near the point of attachment of the moveable finger, there is a cluster of rod-like hairs or setae.

♂ Shape of ventral plate and distribution of the hairs on it as shown in figure. All the legs are rather stout, especially the first two pairs; the legs of the fourth pair are much the longest; second and third tarsi with two or three strong short spines, besides weaker spines and hairs; there are several strong spines on the fourth tarsus, two of them being much longer than the others.

Measurements in mm. ♀ Length of body .72; its width .58. ♂ Length of body .675; its width .476.

Loc.—Newmilns, Ayrshire, Scotland, from *Mus musculus*, 2-ix-1909 (collected by J. Gloag, Waterston Coll.). Howletburn, Galston District, Ayrshire, from *Apodemus sylvaticus*, 30-ix-1910 (J. Gloag, Waterston Coll.). Bute, Scotland; specimens taken by R. W. Sheppard from a wood mouse, 1912 (ex Hon. N. C. Rothschild's Coll.). Hilton, Aberdeen, 3-xii-1910, and Rosehill, Aberdeen, 5-xii-1910, specimens captured by L. G. Esson on *Evotomys glareolus* (ex Hon. N. C. Rothschild's Coll.). Numerous specimens found on field mice (*Apodemus hebridensis*) on Island of Lewis, Outer Hebrides, 6-15-vii, 1914 (G. B. Hony). Ollaberry, Shetland Islands, from field mouse, 2-x-1913 (Waterston). Also examples from "Spitzmaus," locality not given (ex Hon. N. C. Rothschild's Coll.). Zengg, Croatia, 1913, a female specimen found by F. Dobiasch on *Apodemus sylvaticus* (ex Hon. N. C. Rothschild's Coll.).

Laelaps echidninus, Berl.

This species apparently is only found on *Epimys norvegicus*. For the English localities see my little papers on the parasites of Rats (Bull. Ent. Res., 1913, iv, p. 123, and 1914, v, p. 120).

Ptilonyssus nudus, Berl. and Trouess.

A number of female specimens apparently belonging to this species were obtained from a common sparrow killed at Hampton, Middlesex, v-1915, and forwarded to the Museum for examination. In addition to the cephalothoracic shield depicted by Berlese, there is also a moderately large and elongated dorsal shield on the abdominal part of the body, in these female specimens. I cannot, however, find any trace of the little dorsal shield at the hinder end of the body shown in Berlese's figure (see Berlese's Acari, Myr., etc., Ital., fac. 53, no. 10 (1889)). Ventral shield exceedingly short, its posterior end being rounded off; it is united anteriorly with the genital operculum in the

usual way. Anal plate ventral in position, and shaped very like that of a *Liponyssus*; it is furnished with three minute spinules placed in the same position as the three hairs present on this plate in *Liponyssus*, *Laelaps*, etc.

Family Ixodidae.

Genus Ixodes, Latr.

Ixodes vespertilionis, C. L. Koch.

Loc.—Braunton, North Devon, 22-v-1912; a female specimen found by W. Holland on *Rhinolophus ferrum-equinum*. St. Geniès-de-Malgoirès, Gard, France, iv-1910; two nymphs found by Albert Hugues on *R. ferrum-equinum*. Cave de Meaunes, S. France, 20-i-1908; a nymph found by Dr. K. Jordan on *R. ferrum-equinum*. Uj-Moldava, S. Hungary, 1-v-1910; a female specimen found by Lintia Dionisius on *Rhinolophus hipposideros*. Monchique, Portugal, 12-v-1910 (Dr. K. Jordan). All the specimens listed above were presented to the British Museum by the Hon. N. C. Rothschild. I have also examined specimens collected by Mr. T. A. Coward on bats in the Cheddar Caves (see Proc. Zool. Soc., 1907, p. 323). Gonia, Crete, 23-iii-1904; off large horse-shoe bat (Miss D. M. A. Bate). Oumasch, Algeria, 5-iii-1911; a nymph found on a bat (Lord Rothschild and Ernest Hartert). Also numerous specimens (females, nymphs and larvae) from *Rhinolophus hippocrepis* (= *R. ferrum-equinum*) (Koch Coll.).

We have also the co-types of Kolenati's "*Sarconyssus brevipes*," and also larvae and nymphs of his "*S. flavipes*." They seem to me to be fairly typical examples of *I. vespertilionis*, Koch.

Ixodes sp.

In the Koch Collection there are specimens of a tick from *Vespertilio murinus* which is very like *I. vespertilionis*, C. L. Koch, having the legs very long, as in that species, but differing in the following respects:—Base of capitulum not so salient laterally; palpi much shorter, and quite different in shape; anal groove wider, etc. Possibly this is one of Kolenati's species, but his descriptions and figures are so bad that it is impossible to identify the species with certainty.

Ixodes putus, Cambr.

Loc.—Uyea Island, North Mavine, Shetland, 24-iv-1912; a nymph from the fulmar petrel (*Fulmarus glacialis*); Waterston Coll. Little Roe Ids., Shetland, 29-v-1911, a larva and numerous nymphs from the Puffin (*Fratercula arctica*) Waterston Coll. Little Roe Islands, 29-v-1911; a nymph from the Curlew (*Numenius arquata*);

Waterston Coll. Ollaberry, Shetland Islands, 17-v-1913; eleven larvae from *Fratercula arctica*, Waterston Coll. Leith Harbour, South Georgia, xi-1913; four female specimens from a Sooty Albatross, collected by P. Stammwitz during Major G. E. H. Barrett-Hamilton's Expedition. Also five females from black-backed southern gull (Challenger Expedition). The specimens listed above were determined by the author. We have also specimens determined by Prof. L. G. Neumann from the following localities and hosts:—Macquarie Islands; 14-i-1902; five nymphs found on a shag. Shetland Islands; one female from a puffin. Also two female specimens found by Mr. F. W. Frowhawk on a gannet (exact locality not given).

Ixodes unicavatus, Nn.

Loc.—Ollaberry, Shetland Islands, 7-xii-1912; a female and a nymph found on a shag (*Phalacrocorax graculus*); Waterston Coll.).

Ixodes caledonicus, Nutt.

Loc.—Uyea Island, North Mavine, Shetland, 24-iv-1912; a female specimen from the fulmar petrel (*Fulmarus glacialis*); Waterston Coll. Queyfirth, North Mavine, 25-ix-1913, larva from raven (*Corvus corax*); Waterston Coll. Larvae and nymphs from crows (*C. cornix*), 16 and 30-viii.-1910; 28-x-1912; and xii-1912. Also nymphs found by Dr. Saxby on Greenland falcon, Unst, Shetland (Waterston Coll.).

Ixodes percavatus, Nn.
var. rothschildi, N. & W.

Loc.—Morthoe, Devon. A large number of females and nymphs from a puffin. They were determined by R. I. Pocock as *I. putus*, and later by Prof. Neumann as *I. frontalis*, Panzer var.

Ixodes ricinus, L.

Loc.—Ollaberry, Shetland Islands, 11-iv-1913; two nymphs found by the Rev. James Waterston on *Turdus iliacus*. Aros, Mull, Scotland, 13-iv-1896; nymphs and females attached to ears of hare (Barrett-Hamilton Coll). Bellingham, Northumberland; two males and five females found by Major C. F. Bishopp on sheep (supposed by him to convey louping ill, see *Veterin. Journ.*, lxvii, pp. 709-715). River Dart, Devonshire; a nymph found biting man (Dr. W. Makeig-Jones). Porlock Weir, Somerset, 27-iv-1912; a female found by F. J. Cox on a dog (ex Hon. N. C. Rothschild's Coll.). Dorset; female specimens off roe deer. Brockenhurst, New Forest, vi-1915; males and females off dog (R. South). Nuremberg, Germany; males and

females correctly determined by Koch as *I. ricinus*, and also a nymph labelled *Ixodes sciuri*, C. Koch. Near Bucharest, Roumania; two females collected by Major G. E. H. Barrett-Hamilton. Hammam R'irha, Algeria, 1911; a female specimen collected by Hilgert (host not given); ex Hon. N. C. Rothschild's Coll. Scalita, near Trebizond; a female from a Roebuck (Robert Coll.). Soumela, near Trebizond; several females (no host given); Robert Coll.

Ixodes hexagonus, Leach.

Loc.—Loch Tay, Lawers, Scotland; 2-iii-1911, numerous nymphs and a few larvae found by L. G. Esson on *Mustela erminea;* ex Hon. N. C. Rothschild's Coll. Tring, Herts., 12-iii-1912; females and nymphs found by F. J. Cox on *Mustela nivalis* (ex Hon N. C. Rothschild's Coll.). Also two females and two nymphs from the same locality found on *Mustela erminea*. Uppingham, xi-1911; a female specimen found in a house (W. St. B. Griffith). Horsell, Surrey; a female specimen found in a house (W. Darwen). Framlingham, Suffolk; a female from a dog (C. Morley).

Dermacentor reticulatus, Fabr.

Loc.—River Dart, Devonshire; two males and a female forwarded to the British Museum by Dr. W. Makeig-Jones, who informs me that this species is common on the banks of the Dart and Teign; three friends of his found them in their clothes after fishing the former stream. Yeulcupton, Devon, 14-iii-1915; a male and two females found on a lady's dress after a country walk (J. H. Keys). Newton Abbot, Devon; specimens found in a field of lilies (T. H. A. Hind). The specimens listed of this tick above were named by the author, but have since been seen by Prof. G. H. F. Nuttall. I have also examined a specimen from Wales, collected by Sir Bryan Leighton. We have two female specimens from Plymouth, collected by F. W. Frowhawk, and specimens from Revelstoke, N. Devon (hosts not given); these last two lots were determined by R. I. Pocock. The type of *D. clathratus*, C. L. Koch, is in the British Museum Collection—it is a female of *D. reticulatus*.

B.—Descriptions of two New African Mites of the Family Gamasidae.

Haemogamasus liberiensis, n.sp.

Figs. 10 and 11.

Dorsal scutum large, covering the entire upper surface of the body. Hairs on its surface short and very numerous, each of them bears a

pair of short accessory hairs at the base. Hairs on venter also very numerous and close together as on the dorsal scutum, and they are provided with one or two pairs of short accessory hairs. *Sternal plate*

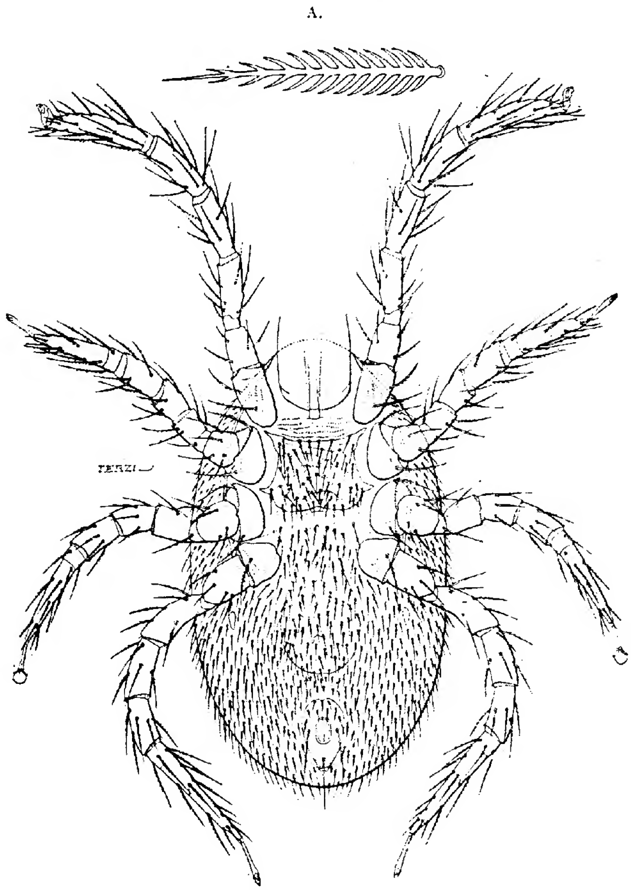


Fig. 10. *Haemogamasus liberiensis*, Hirst, ventral view of female.
A. One of the hairs on the first leg, greatly magnified.

(Fig. 11) furnished with numerous hairs, as in *H. hirsutus*, Berlese, some of them are plain, but others, chiefly those near the margins, have their basal portion feathered. *Genito-ventral plate* rounded pos-

teriorly, being sac-shaped, but it is not very wide; hairs on this plate very numerous, and they often have a pair of short accessory hairs near the base. *Anal plate* pear-shaped, but apparently not so elongated as that of *H. hirsutus*; it is furnished with about eleven hairs, including the three principal ones. *Peritreme* very long, extending forwards beyond the coxae of the first legs and almost reaching the anterior end of the body. *Legs* rather long, tarsus of the fourth much longer than that of the first and more tapering. Nearly all the hairs on the legs are distinctly feathered, instead of being plain as in *H. hirsutus*; the barbules or accessory hairs of the hairs on the first leg are especially well-developed (see Fig. 10 A).

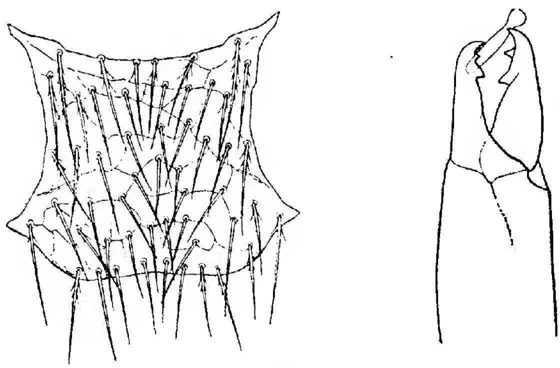


Fig. 11. *Haemogamasus liberiensis*, Hirst; female, sternal plate and chelicera greatly enlarged.

There are also a few rather short plain hairs on each tarsus; those on the first tarsus being quite fine, but the plain hairs on the other tarsi are stouter, being almost spiniform. Distal edges of the segments of the legs rather strongly serrate or spinulose; ventral surface of coxae also ornamented with lines of minute spinules (similar to those present in front of the sternal plate); there may be similar lines of spinules on the other segments of the legs also, but they are not so conspicuous. For the structure of the *chelicera* see Figure 11.

Length of body .875 mm.; its width .56 mm.

Loc.—Gonyon, Liberia. A single example of the female sex found by R. H. Bunting on *Mus trivirgatus*, 20-xi-1910. Ex Hon. N. C. Rothschild's Coll.

Haemolaelaps ? capensis, n.sp.

Figs. 12-14.

♀ *Body*, long oval, *dorsal scutum* fairly wide and large, but usually leaving the hinder end of the body uncovered. Hairs on scutum sparse, fine, and not very long. Hairs on venter very few in number, and distributed as shown in figure 12. *Sternal plate* large, trapezoidal in shape, but

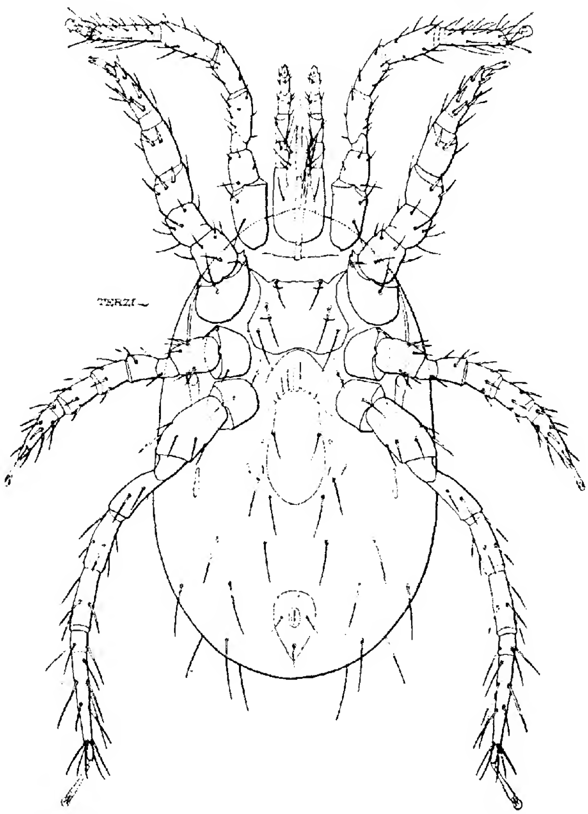


Fig. 12. *Haemolaelaps ? capensis*, Hirst, female, ventral aspect.

with the sides somewhat emarginate; it is ornamented with a reticulate pattern formed by numerous fine anastomosing lines; the three pairs of hairs on this plate are fairly long. *Genito-ventral plate* shaped as shown

in figure, the posterior end being rounded off; this plate is smooth, apparently being without any linear markings, and bears a pair of hairs. *Anal plate* pear-shaped and fairly wide, the three usual hairs are present on it, the posterior unpaired one being slightly longer than the other two. Little lateral platelet very slender and elongated, being almost bacilliform in shape. *Peritreme* long, extending forwards as far as the anterior surface of the first coxa. Median groove of ventral surface of *capitulum* armed with denticles. Immovable finger of *chelicera* armed

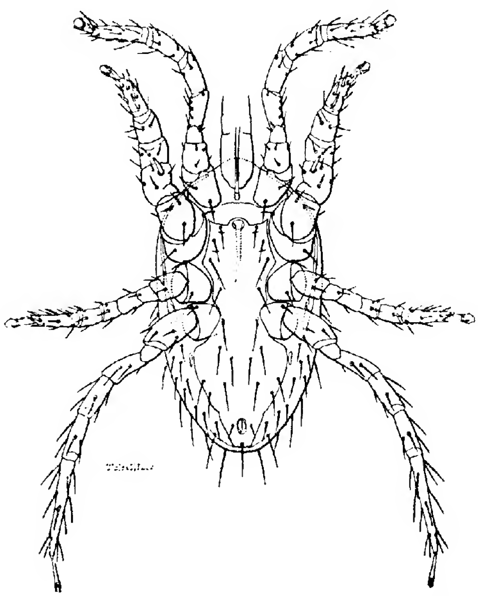


Fig. 13. *Haemolaelaps ? capensis*, Hirst, male, ventral aspect.

with a small tooth placed some distance before the end, and also with two little denticles at the extreme end; proximal half of seta on this finger fairly thick, but the distal part of it slender and slightly curved. Movable finger with two fairly large teeth placed close together, and the end is also strongly turned up and tooth-like. First and fourth pair of legs long, especially the latter; the others shorter, those of the second pair being stout. Tarsus of second leg with about seven very strong spines, besides weaker setae and hairs. There are also a number

of other fairly stout spines on the ventral surface of legs 2-4 (see Figure 12). Setae on fourth tarsus rather long and not very stout.

Length of body .96 mm.; its width .62 mm.

♂ *Genito-ventral plate* shaped as shown in figure; it is ornamented with faint reticulate sculpturing, and bears eleven pairs of long fine hairs, and also the usual unpaired posterior hair. *Chelicera* consisting of two parallel processes, one being strong and ending in a distinct hook, the other considerably longer, but slender and weakly

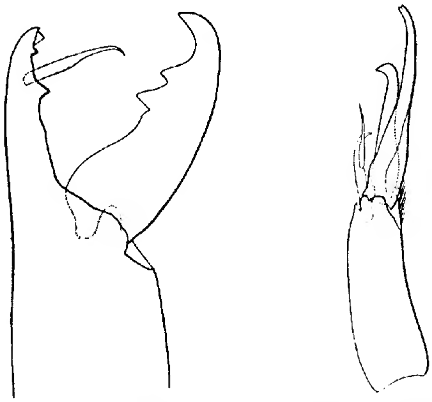


Fig. 11. *Haemolaelaps ? capensis*, Hirst: A. Lateral view of chelicera of female. B. Lateral view of male chelicera.

chitinised, and it is slightly curved. Fourth pair of legs much the longest. Legs of second pair stout; there is an exceptionally strong spine on the femur, and some of the spines on the tarsus of this leg are also strong, as in the female. Fourth tarsus furnished with rather long and slender setae.

Length of body .56 mm.; its width .3 mm.

Loc.—Grahamstown, Cape Colony; a number of specimens found on *Georychus hottentotus* (J. Hewitt).

ON THE MARINE ISOPOD *IDOTEA OCHOTENSIS*, BRANDT.

BY WALTER E. COLLINGE, D.Sc., F.L.S., ETC.,

Research Fellow of the University of St. Andrews,
The Gatty Marine Laboratory, St. Andrews.

WITH PLATE IV.

FOR the opportunity to examine a very fine series of specimens of the Valviferous Isopod *Idotea ochotensis*, Brandt, I am indebted to the kindness of Professor D'Arcy W. Thompson, F.R.S. The series includes examples of both sexes in various stages of growth, the largest male measuring 61 mm., and the largest female 40 mm. in length. All are from St. Paul, Pribyloff Islands.

I. ochotensis was described by Brandt [1] in 1851, and has since been discussed by Miers [2] and Richardson.[3]

As is the case with many other members of this family, accurate figures of the species are the exception; I therefore propose to correct some of those already published of this species, and to supplement them with others, and to offer some remarks upon the structure.

The figures given by Miers are of *I. japonica*, Richardson, and not of *I. ochotensis*, Brandt, as has been pointed out by Miss Richardson. "It is probable," she remarks, "that Miers had specimens of all three species, the one spoken of obtained at Vancouver Island being *I. rectilineata*, Lockington, the specimen from British Columbia being *I. ochotensis*, Brandt, and the Japanese specimen" *I. japonica*, Richardson.

Idotea ochotensis, Brandt.

Pl. IV, figs. 1-12.

Idotea ochotensis, Brandt. Middendorff's Sibirische Reise, 1851, vol. ii, Crust., p. 145, pl. vi, f. 33.

Idotea ochotensis, Miers (*part*). Journ Linn. Soc. Lond., 1881, vol. xvi, p. 32.

Idothea ochotensis, Richardson. Proc, U.S. Nat. Mus., 1899, vol. xxi, p. 846.—Ibid., 1900, vol. xxii, p. 131, f. 1-5.—Ibid., 1904, vol. xxvii, p. 663.—Bull. No. 54, U.S. Nat. Mus., 1905, p. 366, f. 396, 397.

[1] Middendorff's Sibirische Reise, 1851, vol. ii, Crust., p. 145, f. 33.

[2] Journ. Linn. Soc., Lond., 1881, vol. xvi, p. 32.

[3] Proc. U.S. Nat. Mus., 1899, vol. xxi, p. 345; ibid., 1900, vol. xxii, p. 131.

Body oblong-ovate, narrower slightly beyond the 4th mesosomatic segment. Cephalon (fig. 1) a little wider than long, convex dorsally, anterior margin sinuous, posterior margin narrower than the anterior one. Eyes small, transversely ovate, situated on the lateral margin in front of the median transverse line. Antennules (fig. 2) short, 1st joint pyriform, 2nd and 3rd joints much smaller and expanded distally, flagellum a single clavate joint. Antennae (fig. 3) short and robust, 1st joint very small, 2nd and 3rd joints deeply excavate on their outer side, 4th and 5th joints more elongate, subequal; flagellum composed of 15 short joints, and small globular setose style (fig. 4). First maxillae (fig. 5) large, outer lobe terminating in eleven stout, curved spines and a single fine one, inner lobe with three stout setose spines. Maxillipedes (fig. 6) with roughly triangular basal plate, articulating with the inner and smaller division of the coxopodite, palp 4-jointed, epipodite large and articulating with the outer and larger division of the coxopodite, inner distal lobe large and expanded. Segments of the mesosome (fig. 8) subequal, excepting the 1st, the pleural plates of which are directed forward, flanking the postero-lateral margins of the cephalon, and terminating in an oblique truncate margin. Coxal plates prominent, occupying the anterior portion of the lateral margin of the 2nd and 3rd segments, the anterior two-thirds of the 4th, nearly the whole of the 5th, and all of the 6th and 7th. Thoracic appendages (figs. 9 and 10) fairly robust, increasing in size from before backwards. Metasome (fig. 11) composed of two short segments and lateral suture lines, indicating a further partly coalesced segment, and terminal segment; this latter gradually tapers to about its middle, again widening and forming the prominent lateral angles, which are rounded; the posterior margin is produced as a somewhat short, obtuse, triangulate median process, with rounded apex, extending beyond the lateral angles. Dorsal surface slightly convex, but not keeled. Uropoda (fig. 12) flattened, with wide lateral margin on the inner side, posterior margin slightly excavate, endopodite with inner lateral margin straight, bluntly pointed terminally, and cut away on the outer side.

Length of ♂ 61 mm., of ♀ 40 mm. Colour (in alcohol) light reddish-brown.

Habitat.—St Paul, Pribyloff Islands, 1897.

Remarks.—This fine species is very distinct from either *I. rectilineata*, Lockington, or *I. japonica*, Richardson, differing from both in many characters, of which the following are the most important.

The short and expanded antennules, and short, stout antennae.

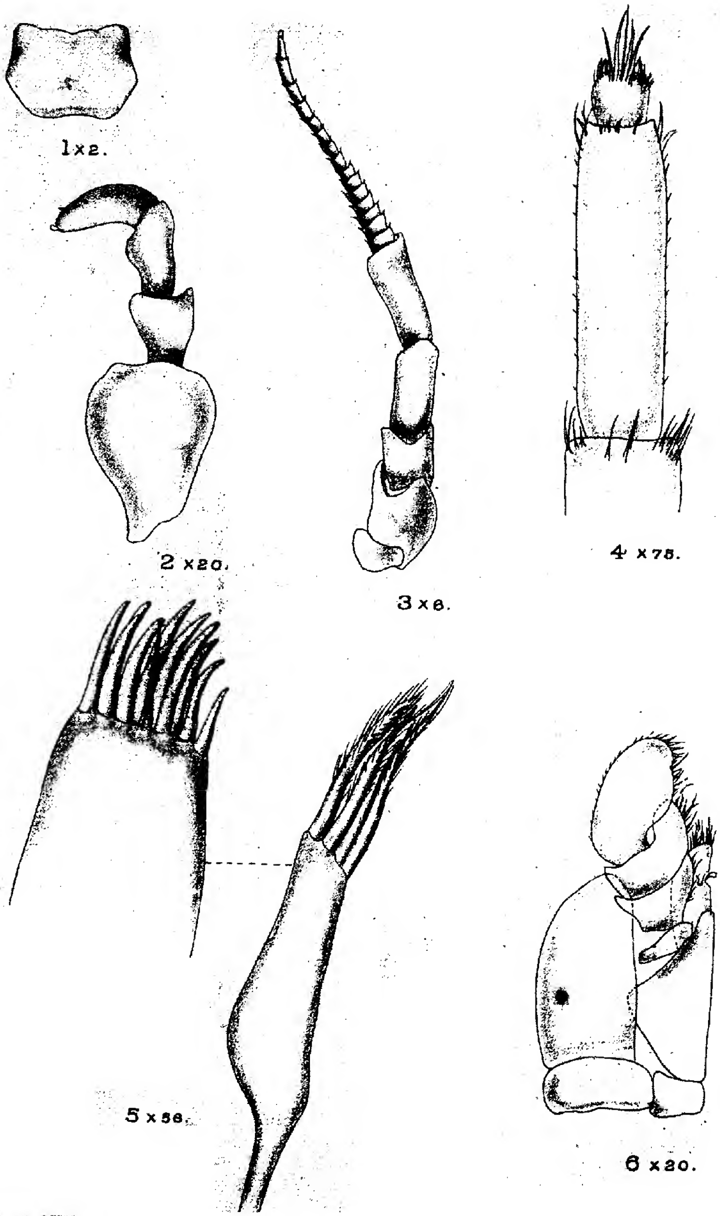
Miss Richardson's figure of the antenna (Proc. U.S. Nat. Mus., vol. xxii, p. 132, f. 4*b*.) is very different from the condition obtaining in the specimens I have examined. In a footnote (p. 133) she remarks that "there is some variation in the length of the second pair of antennae." The terminal style of the antennae is very short and almost globular, fringed with a dense circle of short setae surrounding more elongated central setae. The setose spines on the inner lobe of the first maxillae are remarkably long (fig. 5). The basal plate of the maxillipedes is roughly triangular in shape, and articulates only with the inner division of the coxopodite, the epipodite, which is considerably larger, articulating with the outer and larger division, the distal inner lobe is large and expanded.

Miss Richardson's figure of the maxillipede differs very markedly from that given here, and I cannot help but think that it is incorrect. For purposes of comparison it is reproduced (Pl. IV, fig. 7). I am not acquainted with any genus or species of the Idoteidae in which the basipodite extends below the epipodite.

The appendages of the mesosome are fairly robust, and gradually increase in size from the 1st to the 7th. Those of segments 1—4 are directed forwards, whilst those of 5–7 are directed backwards. In her figure of the 2nd appendage Miss Richardson[1] has omitted to show its chelate nature.

The most striking characters in which *I. ochotensis* differs from *I. rectilineata* and *I. japonica* are seen in the form of the pleural plates of the 1st mesosomatic segment, and the terminal segment of the metasome. In *I. rectilineata* this latter structure has almost parallel sides, with the posterior extremity produced in an obtuse point extending very little beyond the lateral angles. In *I. japonica* the sides are almost straight, the lateral angles are less prominent and obtuse, whilst the posterior extremity is produced as an elongated obtuse spine. In quite small examples of *I. ochotensis* the slightly concave sides, the prominent lateral angles, and the somewhat short, obtuse, triangulate median process, with its rounded apex, readily serve to distinguish it from either of the above-mentioned species.

[1] Bull. No. 54, U.S. Nat. Mus., 1905, p. 133, f. 6 *b*.



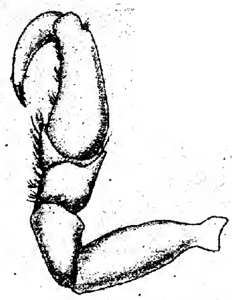
H.G.K. del. ad nat.

IDOTEA OCHC

Pl. IV.

7 ×15½.

8 ×2.



9 ×10.

10 ×10.

11 ×2.

12 ×4.

Huth, London.

HOTENSIS, Brandt.

EXPLANATION OF PLATE IV.

Illustrating Dr. Walter E. Collinge's paper "On the Marine Isopod *Idotea ochotensis*, Brandt."

Idotea ochotensis, Brandt.

Fig. 1. Dorsal view of the cephalon. × 2.
Fig. 2. Dorsal view of the left antennule. × 20.
Fig. 3. Dorsal view of the left antenna. × 6.
Fig. 4. Terminal style of the antenna. × 75.
Fig. 5. Ventral side of the terminal portions of the inner and outer lobes of the right 1st maxilla. × 56.
Fig. 6. Ventral side of the right maxillipede. × 20.
Fig. 7. Ventral side of the left maxillipede (after Richardson). × $15\frac{1}{2}$.
Fig. 8. Dorsal view of the lateral portions of the mesosomatic segments, showing the coxal plates. × 2.
Fig. 9. Ventral view of the 2nd thoracic appendage. × 10.
Fig. 10. Ventral view of the 8th thoracic appendage. × 10.
Fig. 11. Dorsal view of the metasome. × 2.
Fig. 12. Left uropod. × 4.

NOTE ON AN INTERESTING ABNORMALITY IN THE ALIMENTARY CANAL OF THE ISOPOD *IDOTEA LINEARIS* (PENNANT).

By WALTER E. COLLINGE, D.Sc., F.L.S., etc.,

Research Fellow of the University of St. Andrews.

With 2 Text-Figures.

The form and minute structure of the digestive system of the Isopoda are as yet only very imperfectly understood, but, so far as I am aware, in no genus or species yet described does the alimentary canal exhibit any coil or fold upon itself. "In the great majority of Crustacea," Dr. Calman states,[1] "the alimentary canal is nearly straight, except at its anterior end, where it curves downwards to the ventrally placed mouth. The only cases hitherto described in which it is actually coiled upon itself are in certain Cladocera and in a single genus of Cumacea."

Lister[2] writes, "From the upper end of the oesophagus the alimentary canal usually runs straight to its termination, though it is coiled in some Cladocera."

Geoffrey Smith[3] says, "The alimentary canal of the Crustacea is a straight tube."

Richardson[4] observes that in the typical Isopod "the alimentary canal is a straight tube without convolutions."

Similar statements to the above are to be found in most of the text-books on zoology, the following case, therefore, of an abnormal condition, in which the mesenteron exhibits a distinct loop or fold, seems worthy of record.

In dissecting a specimen of *Idotea linearis* (Pennant), previously preserved in 80 per cent. alcohol, in which species the normal canal is perfectly straight, a curious fold was noticed in the portion of the canal lying in the sixth mesosomatic segment (Fig. 1, M.-G.). The canal in this region was swollen out in the form of a globular sac on the right-hand side, then becoming slightly constricted, it expanded again on the left-hand side, and continued as a rather wider tube than elsewhere to about the middle of the seventh segment.

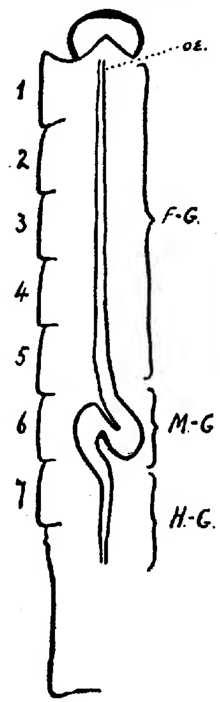
[1] Lankester's Treatise on Zoology. Pt. vii, fas. 3. Crustacea, 1909, p. 14.

[2] Sedgwick's Student's Text-book of Zoology, 1909, vol. iii, p. 351.

[3] Crustacea. Camb. Nat. Hist., 1909, vol. iv, p. 14.

[4] Proc. U.S. Nat. Mus., 1904, vol. xxvii, p. 17.

Before removing the canal from the specimen it was drawn *in situ*. When taken out, the anterior part, viz., that portion situated in the 1st to the 4th segments, was found to be very fragile and to break into pieces, but the portion lying in segments 5 to 7 was removed intact, and after preparation, was stained, and sections were made in order to better illustrate the loop or fold in segment six.



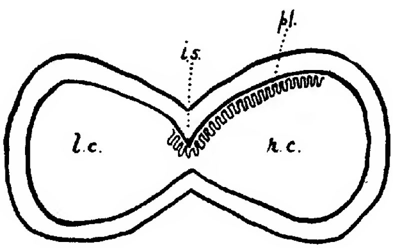


Fig. 2.

Fig. 1. Semi-diagrammatic figure of abnormal alimentary canal of *Idotea linearis* (Pennant).

F.-G. Fore-gut; *H.-G.* Hind-gut; *M.-G.* Mid-gut; *oe.* Oesophagus.

Fig. 2. Diagrammatic transverse section through the abnormal mid-gut.

i.s. Septum; *l.c.* Left cavity; *r.c.* Right cavity; *pl.* Plications of lining epithelium.

It is not my purpose now to describe the structure of the normal alimentary canal of this species, indeed, histologically the sections made were of very little use, beyond that they serve to show the relationship between the two globose sacs just referred to.

The transverse section here shown (Fig. 2) is cut through the middle of the fold, and shows a right and left cavity imperfectly divided by an intervening septum (*i.s.*). The right cavity is slightly larger than the left one, and the whole of the lining epithelium is thrown into a series of minute plications (*pl.*). In the absence of any traces of a chitinous lining in this portion of the canal it may be regarded as the mesenteron or mid-gut.

In connection with an investigation on these Isopoda, large numbers of this and other species, from various localities, have been dissected, but so far this is the only variation from the normal that has been observed.

REVIEWS.

THE BRITISH FRESHWATER RHIZOPODA AND HELIOZOA. By James Cash, G. H. Wailes, assisted by John Hopkinson. Vol. III. Rhizopoda by G. H. Wailes. Pp. xxiii + 156, pls. 33-57, and 50 text-figs. London: The Ray Society, 1915. Price 12s. 6d. net.

The third volume of the Ray Society's British Freshwater Rhizopoda will undoubtedly be useful, but, like the two volumes that preceded it, it is very disappointing. The description of species, the records of distribution, and the detailed analysis of specific characters are necessary parts of the work of zoologists, and constitute an essential element in the progress of zoological science, but it is grievous to find that in any branch of science the systematic naturalist can be so completely detached from problems of morphology, physiology and reproduction as the author of this volume appears to be.

There is no need in a systematic treatise for a full description of the nuclear changes, the conjugation and the formation of swarm spores, but there should be some reference to the principal papers that have appeared dealing with the morphology of the genera described. Thus in this volume we should have expected to find some reference to Schewiakoff's paper on *Euglypha* and to Prandtl's researches on the life-history of *Allogromia*. But if this were found to be too great a strain upon the resources of the author, the reader might at least have been informed that an abstract of these researches may be found in Minchin's *Introduction to the Study of the Protozoa,* which was published three years after the appearance of Volume II of this monograph.

Some information of this kind is really essential if the monograph is to be used by that large class of naturalists of the present day who find interest and relaxation from their business pursuits in the intelligent study of microscopic forms of animal life. It is only misleading to tell them that, for example, the nucleus of a given species is "single, large and granular," when they know that this is only one, even if it is the predominant phase of the nuclear conditions.

Notwithstanding this main fault, the volume will probably be of great assistance to those who wish to take the first step of identifying the species they find in their localities. The volume is illustrated by 25 plates and numerous process blocks in the text. Many of these illustrations are really excellent, and will prove to be of great assistance to the naturalist. The list of synonyms, too, appear to have been drawn up with care and accuracy.

The volume deals with the three families of the Conchulina (or Thecamoebida as the Order is now more usually called), the Euglyphina, Gromiina and Amphistomina, and as an Introduction there is an interesting biographical sketch of the late Mr. James Cash, of Manchester, who took a major part in the production of the first two volumes of the monograph.

S. J. HICKSON.

MORPHOLOGY AND ANTHROPOLOGY. A Handbook for Students. By W. L. H. Duckworth. Second ed., vol. i, pp. xiv + 304, and 208 text figs. Cambridge: The University Press, 1915. Price 10s. 6d. net.

This is a new edition—re-written, in fact—of the first section of the author's deservedly well-known handbook which appeared in 1904. We have never been able to see that the title of the book was accurately indicative of its contents, which form an introduction to the study of the morphological aspects of anthropology, but we have never consulted the work without being impressed with the author's accuracy, thoroughness, caution, and sound judgment. In this enlarged and revised version of the first part of the original single volume, the good qualities referred to stand out as conspicuously as before, and much new material of great interest has been added.

The volume deals practically with the structure of the Primates in relation to that of Man. In the 18th century the great step was taken of applying to Man the methods and results of comparative anatomy; in the 19th century the study became evolutionary and embryological; more specialised craniological and pathological inquiries have made important contributions; more recently the methods of Biometry and of Mendelian research have been profitably applied. Dr. Duckworth restricts himself to morphological anthropology, but he sees this in the light of general biology, and he also recognises that Anthropology is a synthetic science, implying the organisation of many inquiries, *e.g.*, as to language, art, games, keramics, metallurgy, and midwifery—towards the one end, a better understanding of Man. He uses Prof. Tylor's simile, comparing anthropology to the frame used by mountaineers in supporting a miscellaneous load. "The convenience of the frame more than compensates for the slight additional weight imposed by it."

In the clear account given of Mammals in general, useful emphasis is laid on the difference between continuous evolutionary series, in which the links indicate direct lineage, and discontinuous series in which the gaps are wider and the intermediate forms are not necessarily ancestral. We may notice that the Monotreme bone called episternum (pp. 21, 27, etc.) is referred to on p. 30 as interclavicle, a name whose vindication is surely difficult.

The next chapter deals with the Primates in particular, and includes a discussion of Man's position in the order. The careful comparison of Man, a Lemur, and Galeopithecus is very instructive. It is left an open question whether *Pithecanthropus erectus* should be ranked with the Simiidae, or with the Hominidae, or between the two. Dr. Duckworth is not in a hurry over such questions.

The next chapter gives an account of the general structure of Lemuroidea, Tarsii, and Anthropoidea, and is followed by two valuable chapters on the skulls of the Simiidae and the dental system of the Primates. It may be noted that the author is clearly of opinion "that the existing anthropoid apes, constituted as they now are, did not figure in the ancestral history of Man."

We hope that Dr. Duckworth will soon be able to give us the rest of his very effective handbook. The illustrations, which are in great part original, are admirably clear. J. ARTHUR THOMSON.

Vol. 1. OCTOBER, 1916. No. 3.

Contents.

THE

JOURNAL OF ZOOLOGICAL RESEARCH.

A REMARKABLE OOTHECA FROM NYASALAND, WITH NOTES UPON ITS CONTENTS.

By JAMES WATERSTON, B.D., B.Sc.,

Imperial Bureau of Entomology, London.

WITH 3 TEXT-FIGURES.

IN November of last year (1915) the Imperial Bureau of Entomology received from Dr. Lamborn four peculiar structures taken "on thorn bushes, Monkey Bay, Nyasaland," and considered by their discoverer to be "Oothecae, (?)Orthopterous." On breaking up one of these structures it was evident that Dr. Lamborn's diagnosis of their nature was correct, but when the contents of the eggs had been carefully examined, one was surprised to find they could not be of Orthopterous origin. I cannot indeed yet say to what order of insects the enclosed larvae are referable, but the choice appears to lie between Hymenoptera and Coleoptera. In any case the larva must be phytophagous.

The structure now described differs in its great simplicity from anything of a similar nature of which I have been able to read an account. It has little in common with the elaborate Mantid ootheca, of which so many different types are known. There appear to be no separate chambers constructed by the parent insect, the eggs being merely embedded in layers in a matrix which surrounds them completely except where one ovum presses against another.

DESCRIPTION OF OOTHECA.

Colour.—Light chocolate, more or less rufous in tone.

Surface entirely rough and dull. The whole ootheca distinctly hard and breaking with difficulty. In cutting no special cleavage lines were observed, except that the dorsal and terminal portions tended to flake off.

Dimensions.—Length 19-23 mm., height 8-10 mm., breadth 8 mm.

Shape.—The general form is oblong, nearly square in transverse section, with the upper angles rounded, the upper surface roughly

arched and somewhat shortly tapered at the ends. The lower side applied to the twig is concave, having been moulded apparently by the supporting surface. One ootheca evidently placed in the outer angle formed by the main branch and a side twig is abruptly truncate and hollowed at the end as well as below.

Component Material.—Although the general surface viewed by the unaided eye is dull, yet with a moderate magnification innumerable minute, glistening, semi-transparent to whitish lines and duller flakes appear in a uniform reddish-brown matrix. After a small portion of the material had been boiled up with caustic potash (10 %), and further disintegrated by the addition of some glacial acetic acid, it proved easy to separate the bodies referred to and to determine them as epidermal hairs from some plant and thin wood shavings respectively.

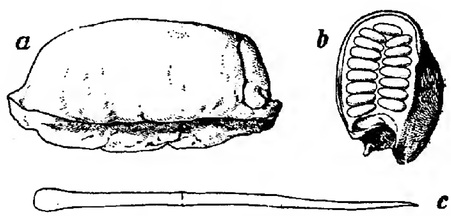


Fig. 1. *a*. Lateral view of ootheca; *b*. Transverse section of same; *c*. Epidermal hair.

The base of the hair (Fig. 1*c*) is slightly swollen, and there are two tranverse septa. Several of the wood sections shew quite plainly the medullary rays. After treating a portion of the ootheca in the manner described, and removing the shavings and hairs, one is left with a dark-coloured liquid and a powdery or flocculent precipitate. I have not been able to detect any change in the composition of the matrix in different parts of the ootheca. If a portion is boiled in plain water and the liquid tested with litmus there is a slight alkaline reaction.

Arrangement and Number of the Eggs.—If one makes a section through the ootheca either (*a*) exactly parallel to the long axis and the supporting bark, or (*b*) transversely in a slightly oblique direction, two rows of large eggs are uncovered (Fig. 1, *b*). In the first direction the rows contain each sixteen to eighteen eggs, in the latter about eight, if in the middle of the ootheca, but rather fewer at the ends. The ootheca therefore contains 250 ova more or less. If in making the cross section the knife passes at right angles to the long axis of the ootheca, frequently only one vertical row of eggs is uncovered, there

being in the other's place a film of the matrix which is opaque even when thin.

The method by which the ootheca is constructed can only be inferred. It may be that a small mass of the building material while still soft is accumulated on the bark to the height (or nearly so) of the finished structure, and a row of eggs embedded and the exposed sides covered up. Another vertical row may then be added projecting forward a little, in front of the anterior edge of the first row—and so on. There is, so far as I can see, no special roofing applied over the eggs.

The origin of the matrix itself presents fewer difficulties. The parent insect, either by a powerful terebra or with its mandibles—perhaps by a combination of these tools, having scraped off numerous hairs and shavings from some plant stem, mixes them together with a cement, which may come either from salivary glands or from the rectum. But there is no clue in the material supplied to tell us whether the ootheca is constructed *in situ* or whether the material is brought from another source.

The Ova.—Dimensions : length $2\frac{1}{4}$ mm. ; breadth and depth about 1 mm.

These lie parallel to the bark, with their long axes at right angles to that of the ootheca. With moderate magnification a rather thick, brittle, biscuit-coloured to yellowish shell and a delicate transparent inner membrane can be made out. All the embryos encased in these membranes were fully formed and of a pinkish colour, which disappeared on boiling in caustic potash, the chitinized portions of the integument being brownish; the head and spiracles of a deeper shade, the circular plates on each side of the mesonotum darkest of all. After heating gently in potash and placing in acetic acid the larvae cleared and extended themselves sufficiently to make possible a detailed study at least of their external anatomy.

Description of Mature Embryo taken from Ova in Ootheca.

Head.—Length from anterior edge of clypeus to vertex .8 mm., breadth .6 mm. Vertex medianly notched with a strong internal incrassation anteriorly to five-eighths of the length of the head. Surface smooth, with about twenty bristles, eight to ten on each side of the middle line, disposed mainly antero-medianly. One ocellus on each side above the antenna. The latter single jointed, resting on a membranous cushion in an antero-ventral hollow above the base of the mandible, forming a cup with two or three sensory (?) pustules on the sides, and a large central triangular process of clear chitin surrounded

by inwardly convergent spines or teeth rising from the rim or base of the cup (Fig. 3*d*).

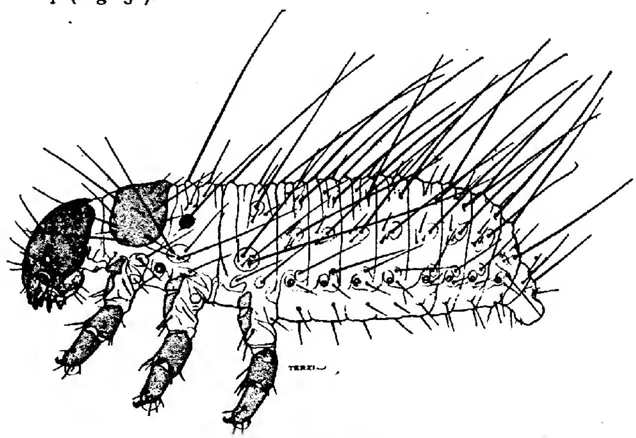


Fig. 2. Mature embryo.

Mouth Parts.—Labrum (Fig. 3*b*), anterior edge deeply emarginate in the middle, each side lobe with one stout lateral bristle. There are also two similar, but shorter, bristles (1 : 1) each, with an associated sensory pustule on the upper surface medianly. Below, on the apex of each lobe, the labrum bears four short spines, behind which are numerous minute appressed bristles directed inwards and transversely

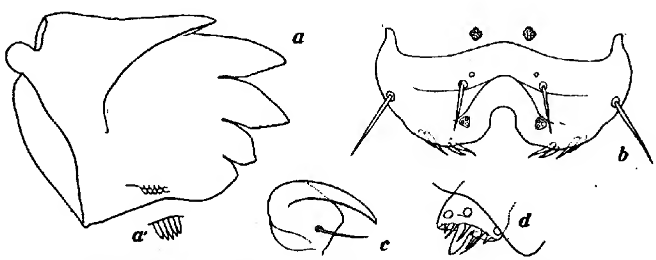


Fig. 3. *a*. Mandible; *a'*. Knife-like spines; *b*. Labrum; *c*. Claw; *d*. Antenna.

towards the mid line. There are also four presumably sensory structures, two anteriorly, one on each side of the emargination, and two posteriorly at the articulation with the clypeus. The anterior pair con-

tain three clear pustules each, the posterior four. Mandibles (Fig. 3*a*) relatively enormous, five teeth, the lowermost (at three-fourths from base) short, thick acute, the next pair large, equal broad acute, the uppermost pair much shorter. Near the upper edge, half-way between the apex of the fifth tooth and the base of the mandible, is a patch of minute, flattened, knife-like spines, standing at right angles to the inner surface of the mandible, and best seen when the mouth parts are viewed from above. Trophi. Maxilla, cardo with one outer lateral bristle at suture, stipes with one moderate bristle near side at half, and another three-fourths the length of the palpus at the base of the latter, which consists of four joints. Galea with eight or nine short, clear apical spines. Labial palpus with three joints.

Thorax and Abdomen (for details see Fig. 2). There are nine spiracles (one prothoracic and eight abdominal) and at least an equal number of abdominal segments, though possibly ten should be reckoned if the last crease represents a true division. The ungues of all the tarsi are well developed, consisting of an anterior narrow claw and a posterior chitinized lamina. Behind each claw is a swollen membranous structure (sucker ?).

Length.—Within the egg the larva is much shrivelled and contracted. The long dorsal and pleural hairs point for the most part anteriorly, and form a pale glistening felted covering. When fully extended in acetic acid the length reaches over 3 mm. in some examples. In a large proportion of larvae so treated the rectum was everted in the form of a long tube.

That the creature is a leaf-eater, feeding, moreover, from the *side* of the leaf is, I think, evident from its morphology. The median incision of the labrum is adapted to a leaf edge: the natural position of the legs, incurved so that in side view only their antero-dorsal aspect is seen, would enable them to hold a thin lamina placed at right angles to the mid-ventral line of the larva. The leaf edge is probably grasped between the thin anterior appendix and the broad basal lamina of the claw, the hold being made more secure by the sucker. The mandibles also are those of a phytophagous larva, though their great development may in part be due to the necessity of cutting a passage out through the hard ootheca.

PARASITES.

Two species of parasites, an Acarid and a Chalcid, were found within the ootheca preying on the ova. The Chalcid (an Encyrtid) probably represents a new genus, and may form the subject of a separate

paper. The Acarid belonged to the genus *Pediculoides*, and a single mature female is, Mr. S. Hirst assures me, not separable specifically from *Pediculoides ventricosus*, Newport (1850).

This mite (which attacks man, often severely) is economically regarded a most useful animal, as it preys upon ova or larvae of such well-known pests as *Sitotroga; Gelechia; Anarsia; Bruchus; Anthonomus;* and *Isosoma*. Its discovery in Nyasaland makes an interesting addition to our knowledge of its distribution. For previous African records, see F. C. Willcocks, in *The Agricultural Journal of Egypt*, p. 31, ff., June, 1914; Raillet, *Tr. Zool. Med. et Agric.*, p. 694, refers to the observations "de Bertherand en Algerie (1888) où Moniez reconnait des individus jeunes de *P. ventricosus*." Mr. Hirst has also shewn me some slides with the data "op larven van Hymenoptera, Abascara (Alg.), 1911, Dr. A. Cros, Ex. Mus. Oudemans, in Brit. Mus."

Unfortunately, neither parasite throws light on the affinities of the host.

ON SOME UNDESCRIBED FEATURES IN THE STRUCTURE OF *CYATHURA CARINATA* (KRÖYER).

By W. OMER COOPER, F.L.S.

WITH 4 TEXT-FIGURES

DURING the Summer of 1915 I came across large numbers of the very interesting Isopod, *Cyathura carinata* (Kröyer), in Christchurch Harbour, Hants, where they were found along the shore under stones and burrowing in the mud, frequently exposing the abdomen above the mud for breathing purposes. Very occasionally they were to be seen swimming near the surface in shallow water. Males were rather more plentiful than females, and the latter were found to be ovigerous in July, the young emerging at the beginning of August. There were eleven young in the only case in which I was able to ascertain the exact number produced. It is worthy of note that the water of Christchurch Harbour is brackish, but has a salinity varying considerably with the tides.

Although this species is very rare in this country—it has only twice previously been recorded from the British Isles—it is well known to carcinologists on account of the numerous descriptions of its anatomy which have been published, and especially the work done on the statocysts in its tail, by Professor Thienemann, who, however, confuses this species with the closely allied *Anthura gracilis* (Montagu). It is therefore somewhat remarkable that the male *Cyathura* appears to be practically unknown, and no description of its structure has been published, though possibly this is to some extent due to the fact that the two sexes, unlike those of most other Anthuridae, are only to be separated by the use of the microscope, and thus the male may have been passed over by workers on the lookout for prominent secondary characters. Consequently, I was very glad of this opportunity of thoroughly examining the structure of the male, which I found to be of the greatest interest, and to well merit a special description.

The male of *Cyathura* is distinguished from those of all other Anthuridae by the structure of its abdominal segments, the first five of which are fused, at any rate dorsally, into a single segment without any trace of suture line; from the genera most closely related to it (*Anthura, Ptilanthura,* etc.) it is also to be distinguished by the rudimentary flagella of its antennulae; while the extraordinary structure of the sexual stilet attached to its second pair of pleopoda differs, not only

from anything found among other Anthuridae, but also from any known structure in the rest of the Isopoda. On account of its morphological interest this last-mentioned organ deserves special attention; unfortunately, I have so far entirely failed in my attempts to find out the uses of its peculiar features. It may be mentioned here that another point of interest in the anatomy of *Cyathura carinata* is that, with the excep-

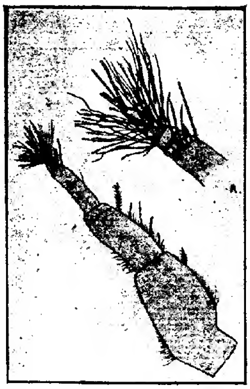


Fig. 1. *Cyathura carinata*. Male. Antennule. A. Flagellum enlarged.

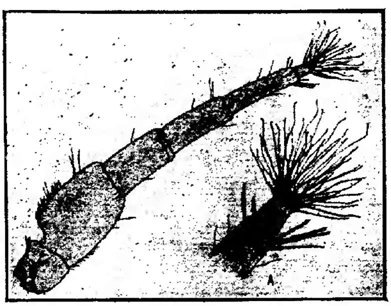


Fig. 2. *Cyathura carinata*. Female. Antennule. A. Flagellum enlarged.

tion of the closely related *Anthura gracilis* (Montagu), this is the only Isopod possessing statocysts.

Description.

Body slightly flattened, sub-cylindrical, of uniform width throughout its length, about eight times as long as broad. Thorax with two

longitudinal carinae on the ventral surface; first segment slightly the longest, second to fifth subequal to each other, sixth and seventh about equal in length and a little shorter than the others.

Abdomen with the first five segments completely fused dorsally in both sexes into a single segment, equal in length to the last of the thorax, but showing in the male traces of segmentation underneath. Telson linguiform, distinctly separated from the very short sixth abdominal segment, rounded, but slightly indented at the extremity, which is without serrations and bears two long setae and a few short hairs, twice as long as broad, with a pair of rather large statocysts,[1] each containing a single statolith, near the base.

Antennulae (Figs. 1 and 2) about two-thirds the length of the antennae; first and second joints subequal in length, first much broader than the second, third slightly shorter, second and third joints bearing a few long setae. Flagellum consisting in the female of a single joint a little shorter than the last of the peduncle, and in the male of four very small joints, the second and third of which bear numerous long sensory hairs; in both cases flagellum terminating in a few long stout papillae.

Antennae consisting of a five-jointed peduncle and a rudimentary flagellum; first joint short and broad, second and fifth about equal in length, second excavated at the base and expanded in the middle, bearing numerous hairs on both inner and outer surfaces, third and fourth joints equal in length, a little shorter than the second. Flagellum consisting of a single joint about one-quarter the length of the last joint of the peduncle, followed by four very minute joints bearing a dense tuft of setae.

Mouth-parts, as described by Schioedte (15, 16), and Norman and Stebbing (11); similar in both sexes.

First pair of peraeopoda or gnathopoda large and strong, sub-chelate; first two joints subequal, the protopodite being as broad as long, meros short and broad, carpus small, almost triangular, projecting so far as to form a point in front of the propodus or hand, which is very large and sub-pyriform, and is strongly setose along the inner margin; dactylus curved and capable of closing on the hand, terminating in a large strong spine or claw, at the base of which is a very small spine.

The other six pairs of peraeopoda adapted for walking and all sub-similar, though the first two, which are directed forwards, show slight traces of a sub-cheliform structure, having the carpus and propodus slightly shorter and more compact than in the four posterior pairs. In

[1] For a detailed description of these structures see Thienemann (19), and Sexton (17).

all the first two joints are subequal in length, the first being considerably the broader, the meros and carpus are together a little shorter than the ischium and about the same length as the propodus, except in the last pair, where the latter is as long as the ischium, propodus somewhat curved inwards, and with the inner margin distinctly crenulated and bearing a rather prominent spine, pectinated at the point, at its distal extremity; dactylus about equal in length to the propodus, with the same structure as in the gnathopoda, though of a much slenderer form than in the latter. All the peraeopoda are strongly setose.

Fig. 4.

Fig. 3. *Cyathura carinata*. Male. Inner branch of 2nd pleopod, showing sexual stilet.

Fig. 4. *Cyathura carinata*. Male. Tip of sexual stilet.

First pair of pleopoda with the outer ramus large, opercular, reaching in both sexes to about two-thirds the length of the telson, fringed with long plumose hairs; inner ramus narrow, respiratory. Other pleopoda consisting of an outer ramus, fringed with hairs and a respiratory inner ramus. Second pair in male with a somewhat strongly-built sexual stilet attached to its inner ramus, and extending a little beyond the end of the pleopoda (Fig. 3) : stilet distinctly jointed at its base, terminating in a spoon-shaped expansion, from the base of which extends a large flattened lobe, standing out at an angle to the

main stem of the organ, from the centre of which springs a slightly curved rod, furnished at the extremity with a crown of about eight large reflexed teeth (Fig. 4).

Uropoda with the inner ramus broad, rounded at the extremity, extending to a little beyond the end of the telson; outer ramus sub-oval, obtusely pointed at the extremity, reaching to the end of the telson, over which it arches, but which it does not nearly cover: both rami without serrations and fringed with plumose setae.

Colour whitish, more or less mottled with brown on the dorsal surface; ventral surface white to brown.

Length 16 mm.; males somewhat larger than females.

Bibliography.

1. De Kay, J. E.—Zool. New York, Crust., 1844, p. 44, pl. ix, fig. 34.
2. Gurney.—Trans. Norfolk & Norwich Nat. Soc., 1907, vol. viii, part 3, pp. 432-3.
3. Harger, O.—Proc. U.S. Nat. Mus., 1879, ii, p. 162.
4. Harger, O.—Report U.S. Comm. of Fish and Fisheries. Part 6, 1880, pp. 398-402, pl. xi, figs. 68-69.
5. Harger, O., and Verrill, A. E.—Report U.S. Comm. of Fish and Fisheries. Part 1, 1873, p. 572 (278); p. 426.
6. Kröyer, H.—Naturh. Tidsskr., 1846-49 (2), ii, p. 402.
7. Kröyer, H.—Voyage en Scand., 1849, pl. xxvii, fig. 3.
8. Kuhlgatz, T.—Wissenschaftliche Meeresuntersuchungen, 1898, iii, pp. 148-149, pl. iii, figs. 4-19.
9. Meinert, Fr.—Naturh. Tidsskr., 1877 (3), xi, p. 77; 1880, xii, p. 470.
10. Milne-Edwards, H.—Hist. des Crust., 1840, iii, p. 126, pl. xxi, fig. 3.
11. Norman, A. M., and Stebbing, T. R. R.—Trans. Zool. Soc. Lond., 1886, xii, part 4, pp. 124-125, pl. xxvii.
12. Richardson, H.—American Naturalist, 1900, xxxiv, p. 215.
13. Richardson, H.—Proc. U.S. Nat. Mus., 1901, xxiii, p. 508.
14. Richardson, H.—Isopods of North America, 1905, pp. 63-65, figs. 47-50.
15. Schioedte, J. C.—Naturh. Tidsskr., 1875-76 (3), x, p. 211, pl. iv, figs, 1-14.
16. Schioedte, J. C.—Ann. Mag. Nat. Hist., 1876 (4), xviii, p. 253.
17. Sexton.—Journal of the M.B.A. of U.K., 1914, vol. x, No. 2, pp. 330-43, 12 figs.
18. Stimpson, W.—Proc. Acad. Nat. Sci. Phila., 1856, vii, p. 393.
19. Thienemann, A.—Statocysten bei *Anthura gracilis*, Leach. Zool. Anz., 1903, xxvi, pp. 406-410, 2 figs.

THE SPAWNING AND EXUVIATION OF *ARENICOLA*.

By H. CHAS. WILLIAMSON, M.A., D.Sc.,
Marine Laboratory, Aberdeen.

WITH 13 TEXT-FIGURES.

THE worms here dealt with were obtained from the beach, Bay of Nigg. No care was taken to notice that all the specimens were *Arenicola marina*. I think that they probably all belonged to that species. If any specimen of *A. ecaudata* had occurred among the collection it would probably have attracted attention. The worms were not preserved after the experiment finished.

Gelatinous spawn masses which are to be found between tide-marks, on the sand or attached to stones and weeds, have been ascribed to *Arenicola* and *Scoloplos armiger*. According to Leschke (10) the eggs of *Terebella zostericola* and *Terebellides stroemi* are also laid in a mucous mass attached to seaweed, or the mouth of the tube. The eggs of the latter are about .072 mm. in diameter, and almost black in colour, the egg-mass being about 4 mm. in diameter. The larva of the former is ochre-yellow in colour. Leschke also states that the eggs of *Nereis dumerilii* are clear yellow, very translucent, and exhibit four large oil globules. They may be found either floating or on the walls of the tunnel of the worm.

According to M'Intosh (11), Lo Bianco found *Nereis cultrifera* mature and depositing ova at Naples from May to June, the yellowish ova being enveloped in mucus on algae dredged at some depth.

M'Intosh (11) and Ashworth (1) both give summaries of the records of spawn-cocoons.

According to the former author, M. Sars, in 1845 described the grass-green eggs of what he considered to be *Arenicola*, enveloped in mucus, and he noticed segmentation and hatching of the young (with red eyes) which he figures. "They occurred in February and March, at a depth of some feet, adhering to Zostera and Fuci. The relationship of these to *Arenicola*, however, is uncertain. Max Schultze, in 1856, detailed the development . . . yet the roseate gelatinous masses with a long pedicle of mucus which he procured at Cuxhaven [in February] appear to belong to *Scoloplos armiger*, or a similar species, the bristles especially differing from those of *Arenicola*."

Cunningham and Ramage (5) found at the beginning of February large numbers of gelatinous cocoons on the surface of the sands (Firth of Forth) at low tide. The cocoons were about 2 × 1 cm., pear-shaped, and the narrower end was prolonged into a long cylindrical stalk about 3 cm. in length which contains no ova. The stalk is usually embedded in the sand. The ova and embryos were opaque white; the jelly transparent. The colour may not be a constant attribute. The larva is in certain points more like the adult *Scoloplos armiger* than the adult *Arenicola*. It was found that *Arenicola marina* does not shed its genital elements until August and September.

Ehlers (6) said that it had become doubtful whether the spawn-balls investigated by Schultze and himself, and the larvae hatched from them do belong to *Arenicola*, since the *Arenicola* of the North Sea are distended with ripe or nearly ripe sexual products as early as September.

According to Ashworth (1), Ehlers and Fauvel ascribed these egg-masses to *Scoloplos armiger*, and Groot definitely proved their parentage by finding them in an aquarium in which specimens of *Scoloplos armiger*, but no examples of *Arenicola*, were living.

M'Intosh (11) records that Hornell, on March 2nd, procured on a sandy beach at Egremont, small, gelatinous, pear-shaped, brownish egg-masses, the annelid (*Scoloplos armiger*) being in close proximity to them. The brownish cocoons are smaller than the green ones of *Arenicola*, and are anchored amongst the bare ripple furrows of the sand.

M'Intosh refers to certain egg-masses as follows:—"Numerous pale-green gelatinous masses about the size of a small gooseberry were found by the fishermen digging for *Arenicola*, on the 3rd May, usually with a long strand of mucus at one end. None was found there on the preceding day."

"At certain times of the year, chiefly in spring," Gamble and Ashworth (7) state, "the nets used by shrimpers on the sandy coast near Lytham are almost choked by the balls of eggs, each moored by two 'cables' to the sand. Whether these eggs belong to *Arenicola* remains to be seen, but their form differs from that of *Phyllodoce*, found so commonly in early spring."

"The green egg-masses so frequently referred to as belonging to *Arenicola* are," Benham says (3), "laid by Phyllodocids. According to a verbal communication from Mr. J. Hornell of Jersey they belong to *P. maculata*, Müll., while Mr. Garstang believes them to belong to *Eulalia viridis*."

M'Intosh (11) states that some *Phyllodoce lamelligera*, Gmelin,

"deposited green ova in a gelatinous mass in May. The animal readily secretes a large quantity of mucus, and in this the eggs very probably are immersed. A ripe male, which is distinguished by the paler-yellowish hue of the body and the bases of the feet—caused by the masses of white sperms—occurred in June (19th). The sperms have a comparatively large head and long slender tail." Referring to *P. maculata*, Linn., the same author states, "The ripe females (June 18th) undergo a considerable change in colour, due to the development of the green ova internally. The early development of the ova, which are of a fine green colour, and which are deposited in a somewhat bulky gelatinous mass—"

Ashworth (2) concludes that we can only suggest by inference from the known facts of development of other species of *Arenicola* that the eggs are laid, probably entangled in mucous, on or in the sand in shallow water, and he adds (1), "In spite of the abundance in innumerable places of the adult worm, and of much searching by many workers, the egg-masses of *Arenicola* have never been found on the coast of Europe."

I have observed the green egg-masses on the sand and attached to stones and weeds in the Bay of Nigg, in May and July. On one occasion (July), when many were to be seen on seaweeds, I saw none on a patch of sand (close at hand, but further seaward) upon which a few sand-castings of *Arenicola* were visible. In July of another year a large number of the spawn cocoons were noticed on sand. The spawn was looked for once in June, and once in September, but on neither occasion was any found. It seems likely that sea-birds may eat the spawn, and that may account for its absence sometimes.

I have been informed by Mr. Fraser, attendant of this Laboratory, that many similar green masses about 18 mm. in diameter, were seen on the walls and bottom of the plaice pond on July 3rd, 1916, when it was cleaned. The sides and bottom of the pond are of concrete. Some *Nereis* were observed, but no *Arenicola* was noticed in the pond.

I have the following note under July, 1912. A long, rope-like, gelatinous body 45 to 50 cm. in length and nearly 1.2 cm. thick was found in the pond. It was formed of small cells, and snapped across when handled. It does not seem to have been preserved, nor did any further examination appear to have been made of it.

Various observations bearing upon the development of the reproductive organs of the worm have been recorded. According to Kyle (9), *Arenicola* seems to spawn during a period extending from January to September, though there is a cessation during April, May, and the first part of June.

The ordinary littoral *Arenicola marina* of the Lancashire coast and of the Isle of Man are, Gamble and Ashworth state, not mature in the spring, and contain at most a few very small eggs. In the summer (August) of 1896 they found mature specimens, and they believe that this variety breeds through the summer, commencing at about the time when the deeper-water form has ceased. "As is well known, the ova and the spermatozoa escape by the nephridiopores, but it does not seem to have been noticed before that in both males and females the bladders of the last five pairs of nephridia are specially enlarged and contain mature ova or spermatozoa, so that upon irritation a simultaneous discharge through all these apertures may occur. In one form, only 8 inches in length, the bladder of the nephridium was swollen with ova so as to measure 14 mm. in length and 6 mm. in width. During the discharge of ova from the female the eggs are caught by the slimy mucous covering of the body, and owing to the movements of the animal collect in strings round the body." They have not observed the formation of gelatinous capsules in which the eggs may be laid, since they have not worked at the oviposition of the species, about which nothing is at present known. . . . In the spherical ripe ova (which measures .16 mm. in diameter) a distinct but very thin vitelline membrane is present, and a small quantity of food yolk in the form of very small granules in the protoplasm.

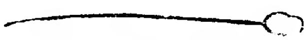


Fig. A. Sperm of *Arenicola*.

On October 2nd, the water in a box in which some *Arenicola* were living was seen at one part to be clouded with sperms. The following day a white powder was lying in little heaps on the bottom : it consisted of lively sperms. Four days later I saw no trace of the sperms on the bottom. The drawing which I made at the time (Fig. A), shows a general resemblance to Ashworth's (2) figure of the sperm. When examined on a slide the sperm wriggled actively, and then became anchored to the glass by the end of the tail, while the head remained free and swung about. I did not notice any ova in the water.

I have made three experiments with the object of obtaining the normally spawned eggs of *Arenicola*. Examples of the worm have been kept in a box, the bottom of which was covered with a thick layer of sand; a current of water ran constantly through the box. The experiments were started respectively in March 1910, July 1912, and May 1914. The worms lived quite well in confinement. Only in the last

experiment were what I regard as the spawn capsules of this form deposited.

On May 14th, 1914, a number of *Arenicola* from the Bay of Nigg were put into a box supplied with running water. Some sand brought from the place where the worms were obtained was also put into the

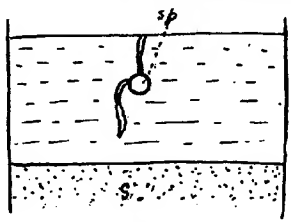


Fig. 1.

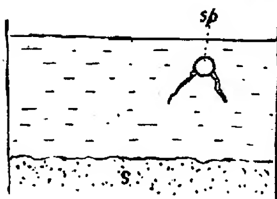


Fig. 3.

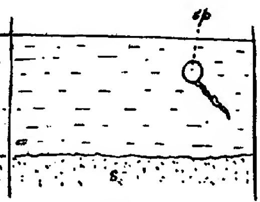


Fig. 4.

Figs. 1, 3 and 4. Spawn capsules (*sp*) deposited in box in Laboratory. *s*. Sand.

box. The sand was examined by breaking it into lumps to see if other worms were present. One or two very thin worms, probably *Capitella*, sp., were noticed. On May 30th, a green capsule of ova was found in the box (Fig. 1). It was stuck to the side, 7 to 10 cm. above the sand. There was a track-like mark from it to the surface of the water. The capsule was smaller than many of the capsules seen on the beach.

Fig. 2. Larva in spawn capsule.

The eggs were green. One of them measured .1 mm. in diameter. It showed practically no perivitelline space. There were groups of darker-green granules in the egg. An egg preserved at this date exhibited more than sixteen cells.

A second green spawn capsule was found on June 7th. It had

been spawned between June 5th and 7th. There was a slimy trail on the wall, but it did not extend up to the surface of the water. Four days later I examined the ova. The larva had two eye-spots (Fig. 2). A zone round the larva had long, thick, tentacle-like cilia, which were turned towards the eyed end. The cilia worked for a little, and stopped, almost every second. Two days later still, the spawn capsule retained its shape, but it had largely lost its colour. A few green larvae were still in it, but they seemed to be little, if any, advanced on the condition at the previous examination. The larvae do not seem to have much room to move in. No dead larvae were observed in the capsule. June 28th, a third green capsule was obtained (Fig. 3). It was stuck about 3½ inches above the sand and 1½ inches below the surface of the water. Four days later only a few larval worms were still in the capsule. June 30th, a fourth green capsule was found (Fig. 4). It was about 3 inches above the sand and 2 inches below the surface of the water. July 29th, no more green capsules had been deposited. The box was cleaned out on this date. I found in the sand large and small *Arenicola*, and a worm which Professor M'Intosh kindly diagnosed as *Capitella capitata*. Large numbers of larvae of *Polydora ciliata* were observed in the water circulating in the Laboratory, and small examples of this worm were found in the sand of one of the boxes. I have no doubt that the green capsules which appeared in the Arenicola box were spawned by *Arenicola*. There are two alternatives to that view—first that they are the spawn of *Capitella capitata* or of *Polydora ciliata*, or that they had been deposited by a worm or worms which had passed through the box. Precautions were not taken to prevent the entry of a worm per the water supply, so that such a contingency cannot be regarded as impossible, although it appears unlikely.

The spawn masses do not belong to either *Capitella* or *Polydora*. The eggs of the former are, Mr. M'Intosh says, dark greyish brown. A larva obtained at St. Andrews had purplish pigment, whereas in a larva obtained by Leschke at Kiel, the pigment was greenish. Leschke states that the eggs of *Polydora ciliata* are round, opaque, of a dark brown colour: they are laid singly, not in a jelly mass. The spawn capsules which had been deposited in the box were all of relatively similar size, and appeared small compared to the green capsules usually found on the beach. One of the former in alcohol measured 6 × 5 mm.: a beach capsule in alcohol measured 6 × 5 mm., but was thicker than the specimen spawned in the Laboratory. A beach capsule preserved in formaline was fully 10 × 10 mm. A Laboratory capsule from which some of the eggs had been hatched measured in formaline

4 × 3·5 mm. On one occasion in July the largest capsule taken from the beach measured in the fresh condition 17 mm. in diameter. The spawn capsules shrank very much in alcohol.

In the spawn capsule from the beach the eggs appear to be arranged inside the albuminous mass in linear fashion, wound round in a ball. In some places a single row of eggs composed the line: at others the line was of irregular thickness of eggs. The gelatinous mass is enclosed in a loose skin that shows a ruffled outline (Fig. 5). Further examination shows that the supposed gelatinous mass is a ball of rolled-up fibres. Similarly, in the spawn capsule laid in the Laboratory, the eggs are embedded in a mass of fibre material. The enclosing outer skin is not so easily demonstrated on this capsule, but the anchoring processes are present, and one of them was seen to consist of a network of fibres. The latter was probably connected with the egg-ball.

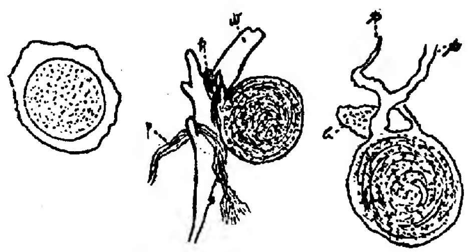


Fig. 5. Fig. 6. Fig. 7.

Figs. 5, 6 and 7. Spawn Capsules. *b*. Torn portion of capsule; *p*. Process of capsule; *w*, Seaweed.

Fig. 6 exhibits a spawn capsule from the beach attached to a weed, and Fig. 7 shows it detached from the same. It is fastened to the weed by soft filmy processes which wrap round the weed. They are continuations of the skin which encloses the spawn mass. What is this enveloping skin? It is, I consider, the old cuticle of the *Arenicola*, which is cast off every now and then as a complete tube. When an *Arenicola* is dug up, and handled a little later, a complete tube-like envelope, to which sand grains adhere, may be drawn off its body.

When this annelid was kept alive in the Laboratory, it was observed to frequently cast its skin. The skin may assume various forms. It may appear as a sort of balloon anchored to the sand (Figs. 8 and 9), or it may be found stretching over the bottom with both ends sunk into the sand (Fig. 10). Whether the balloon-shaped cuticle is attached at the point where the worm issued from or re-entered the sand is at present an open question.

Fig. 11 shows the old skin inverted. It looks as if the worm had issued partly from its burrow, and then retracted itself, leaving the cuticle outside and partly inverted.

The occurrence of the cast cuticle may be an indication of the worm shifting its quarters, but it does not mean that the *Arenicola* exuviates on every occasion it deserts its tunnel to form another. It is also evident that the cuticle may be cast off by a worm which has simply issued partly from the hole and retreated to the same. Sand-castings (faeces) were observed inside one exuvium. One exuvium showed on examination segmentation, and I made gill-patterns out on it, and on another example.

Fig. 8. Fig. 9. Fig. 11. Fig. 12.

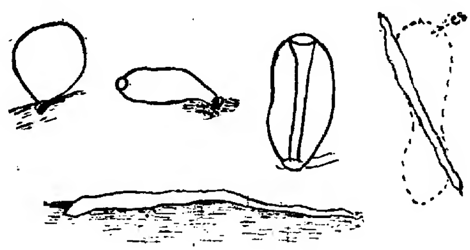


Fig. 10.

Figs. 8—12. Cast Skins of *Arenicola*. *cs*. Space on sand, cleared of mud,

The old skin is of a thin, plain, amorphous appearance, showing under one-sixth inch objective no fibrous structure. It gradually decays in the water: one lasted in May for three days: on the fifth day it had disappeared. I have watched *Arenicola* bury themselves in the sand: some disappeared in less than twenty minutes.

The *Arenicola* does not seem to crawl on the sand. Even when the sand in the box was covered with a coating of fine mud I did not see any tracks such as a crawling worm would make. In one case, where the exuvium stretched across the bottom, being attached at both ends, the mud was scraped away over an area, as if the worm had been swaying about, possibly trying to get free from the old skin before it burrowed again (Fig. 12).

The changes in distension to which the body of the worm is from time to time subject may cause the loosening of the cuticle. A light gelatinous cuticle may be dissected off the worm. In one case it was loose over the head end and came away easily there. On another

specimen it adhered fairly tightly, but came away in shreds. I have observed that *Arenicola* in confinement have cast their skins in the following months, viz., February, March, April, May, July, August, September, October, November.

Kyle (9) refers to the difference in appearance of the "exudation" of worms inhabiting different kinds of ground:—"From the clean, bright, gritty sand a form is got of fine golden colour, with a smooth and glossy exterior, and exuding from its surface a gelatinous substance which is quite clear and transparent: from the muddy clay-flats another form is procured which has a rough and coarse appearance, is of a dark dirty-brown colour, and gives off from its skin a green slimy gelatinous material."

According to Benham (3) Garstang described two small *Arenicola*, 6.8 mm. in length, as follows:—"Each was inhabiting a perfectly colourless and transparent gelatinous tube, obviously secreted by itself. The body of the larva was very flexible when alive, enabling it to wriggle actively in an eel-like manner in the water—generally near the surface—when placed in a tall, clear glass jar. The gelatinous tube seemed to invest the body closely, and was certainly no impediment to the animal."

Giard (8) describes metamorphosis through exuviation in the parasitic worm *Ascaris*.

I found a skin of *Nereis* apparently exuviated, but the fact that bristles were attached to the skin, which was much more substantial than that of *Arenicola*, led me to doubt whether I was dealing with an exuvium.

From the fact that the spawn mass may be attached to weeds and stones above the surface of the sand, it is evident that the worms must in some cases be swimming when they spawn. In one case the spawn was on a stone at a point fully 6 inches above the bottom.

Ashworth (1) writes as follows:—"Beyond the statement by Bohn that *A. marina* leaves its burrow at night to swim in the sea, nothing is known of the habits of this worm when covered by the sea. Ehlers has recorded the swimming of *A. marina*, and the capture, before sunrise, of specimens 80 to 120 mm. long, in the surface tournet in shallow water at Heligoland. Chadwick observed a specimen make its way slowly upwards, in a large aquarium tank, by strong and frequent flexions of the body. . . . Fauvel saw examples of *Arenicola ecaudata* which were kept in an aquarium leave the sand during the night to wander about at the surface of the water or to swim freely. Each was surrounded by a thick envelope of mucus. On a light being brought

near the aquarium, the worms at once began to burrow into the sand, leaving behind their mucous envelopes."

One may assume that in the sea the *Arenicola* will not leave its burrow except when the water is smooth, and that the deposit of the spawn on the sand or weed may be determined by the weather. I did not at any time during the day see a live *Arenicola* above the sand in the box. On one occasion the tail of a worm appeared : a casting was ejected, and the tail disappeared.

As corroborative evidence of the swimming of *Arenicola* may be cited the occurrence of the worm in the stomach of fishes, *e.g.*, *Pleuronectes platessa, P. limanda, P. flesus, Gadus morrhua, G. aeglfinus, G. merlangus,* and *Trigla gunardus,* as Ramsay Smith (13) and T. Scott (12) record.

In conclusion, I may say that I have no doubt that certain of the green balls of spawn met with on the beach between tide-marks are those of *Arenicola*.

Literature Consulted.

1. Ashworth, J. H.—Arenicolidae in British Museum. Plates. 1916.
2. ———— Arenicola. Liverpool Marine Biology Committee. 1904, pp. 118, pls. i-viii.
3. Benham, W. B.—The Post-larval Stage of *Arenicola marina.* Jour. Mar. Biol., Assoc., 1893-95.
4. ———— Polychaeta. Cambridge Natural History. 1910.
5. Cunningham, J. T., and Ramage, G. A.—The Polychaeta sedentaria. Trans. Roy. Soc., Edin., 1888, vol. xxxiii.
6. Ehlers, E.—Die Gehörorgane der Arenicolen. Zeit. f. wiss Zool., 1892, Bd. liii.
7. Gamble and Ashworth.—The Habits and Structure of *Arenicola marina.* Quart. J. Micro. Science, 1899, vol. xli.
8. Giard, A.—Exuviations métamorphiques chez les Ascarides des Poissons. C.R. des Seances de la Société de Biologie, 1903, T. lv.
9. Kyle, H. M.—On the Nephridia Reproductive organs and post-larval stages of *Arenicola.* Ann. Mag. Nat. Hist., 1896, vol. xviii.
10. Leschke, M.—Beiträge zur Kenntniss der pelag. Polychaetenlarven, &c. Kiel Comm. wiss. Meeresunt (Kiel), 1903, Bd. vii.
11. M'Intosh, W. C.—The British Marine Annelids. Ray Society, 1873-1916.
12. Scott, T.—Observations on the Food of Fishes. 20th Ann. Rep. Fish. Board, Scotland. Pt. III, 1902.
13. Smith, W. Ramsay.—On the Food of Fishes. 7th, 8th, 9th, 10th Ann. Rep. Fish. Board, Scotland. Pt. III, 1889-1892.

ON THE STRUCTURE OF THE MARINE ISOPOD *MESIDOTEA SIBIRICA* (BIRULA), WITH SOME REMARKS UPON ALLIED GENERA.

By WALTER E. COLLINGE, D.Sc., F.L.S.,
Research Fellow of the University of St. Andrews.
The Gatty Marine Laboratory, St. Andrews.

WITH PLATE V.

So far as I am aware no complete description has yet been published of the Isopod known as *Glyptonotus sibiricus*, Birula, and no complete account or figures have been given of its structure. Professor D'Arcy W. Thompson, F.R.S., having very kindly placed a specimen at my disposal, in addition to many other allied species, I have endeavoured in the following pages to redescribe Birula's species, and figure and describe the leading structural characters, and also to give some notes on the allied species and genera.

The genus *Glyptonotus* was originally described by Eights (2) with the *G. antarcticus*, Eights, as the type. This species is the largest of those forms included in the subfamilies Glyptonotinae, Miers, and Mesidoteinae, Racovitza and Sevastos, attaining a length of nearly 90 mm.

In 1878 Harger (4) described the new genus *Chiridotea*, in which he placed the *Idotea caeca* of Say, and the *Idotea tuftsii* of Stimpson, both species being characterized by having the coxal plates distinctly separated from the segments of the mesosome; a 3-jointed palp on the maxillipedes; and a metasome composed of four segments.

Sars, in 1885 (12), described and figured *Glyptonotus megalurus*, having previously (10) first regarded it as a variety of *G. sabini* (Kröyer), and later (11) as a new species of *Chiridotea*, Harger.

Miers (6), in 1881, placed all the known species, viz., *antarcticus*, Eights, *entomon* (Linn.), *sabini* (Kröyer), *caecus* (Say), and *tuftsii* (Stimpson), in the genus *Glyptonotus*. Sars' *G. megalurus* he regarded as synonymous with *G. sabini*.

In 1887 Hansen (3) gave an account of the maxillae and maxillipedes of *G. entomon* (Linn.) from the Kara Sea, but, he informs me (*in litt.* Dec. 7th, 1915) that all his specimens were really referable to *G. sibiricus*, Birula, an "allied but certainly valid species." In this

paper Hansen discussed the structure of the 1st and 2nd maxillae and the maxillipede, and gave figures of the 1st maxilla and the maxillipede. In the former the setules are not shown, and there are some slight differences from the figure given on Pl. V, fig. 6, in the maxillipede.

In 1896 Birula (1) described *G. sibiricus* from the Kara Sea. The description is very brief and no figures are given of the animal or its structure.

Richardson, in 1904 (8), described the genus *Symmius* for a small but interesting species collected at a depth of 60 to 70 fathoms at Ose Zaki, Japan. This genus differs from *Glyptonotus*, Eights, in the following characters:—The lateral margins of the cephalon are entire; the eyes are situated on the lateral lobes of the cephalon; the flagella of the antennae are each composed of a single joint; the metasome is composed of three segments; there is a 3-jointed palp to the maxillipedes, and the uropoda each consist of a single piece.

In 1905 Richardson (9) separated *Glyptonotus entomon* (Linn.) and *G. sabini* (Kröyer), placing them in a new genus—*Mesidotea*, both species possessing a 5-jointed palp on the maxillipedes. The former species, under various generic names, had previously been described and figured by Pallas, Klein, De Geer, Latreille, Rathke, Kowalevsky, and others; whilst Kröyer (5) described and figured the latter species in 1847.

In 1910 (7) Racovitza and Sevastos described a new fossil species, for which they erected the genus *Proidotea*, which, together with *Chiridotea*, Harger, and *Mesidotea*, Richardson, they placed in a new subfamily—*Mesidoteinae*.

The list of species of the two above-mentioned subfamilies, known up to the present time is as follows:—

Family IDOTEIDAE.

Subfamily GLYPTONOTINAE, Miers.

Genus **Glyptonotus**, Eights.

1. *G. antarcticus*, Eights,

Genus **Symmius**, Richardson.

2. *S. caudatus*, Richardson.

Subfamily MESIDOTEINAE, Racovitza and Sevastos.[1]

Genus **Chiridotea**, Harger.

3. *C. caeca* (Say).
4. *C. tuftsii* (Stimpson).

[1] Ohlin's *Macrochiridothea* may possibly come in under this subfamily. As yet I have not been fortunate enough to examine specimens.

Genus **Mesidotea,** Richardson.

5. *M. entomon* (Linn.).
6. *M. sabini* (Kröyer).
7. *M. megalura* (G. O. Sars).
8. *M. sibirica* (Birula), em. Collinge.

Genus **Proidotea,** Rac. & Sev.

9. *P. haugi,* Rac. and Sev.

KEY TO THE GENERA.

Subfamily GLYPTONOTINAE, Miers.

I.—Coxal plates distinct on the three posterior mesosomatic segments.

a. Lateral margins of cephalon cleft.

i. Metasome composed of 5 segments.

ii. Maxillipede with a 3—5-jointed palp.

Glyptonotus, Eights.

b. Lateral margins of cephalon entire.

i. Metasome composed of 3 segments.

ii. Maxillipede with a 3-jointed palp.[1]

Symmius, Richardson.

Subfamily MESIDOTEINAE, Rac. and Sev.

II.—Coxal plates distinctly separated on 2nd—7th mesosomatic segments.

a. Lateral margins of cephalon cleft.

i. Metasome composed of 4 segments.

ii. Maxillipedes with a 3-joined palp.

Chiridotea, Harger.

i. Metasome composed of 5 segments.

ii. Maxillipedes with a 5-jointed palp.

Mesidotea, Richardson.

b. Lateral margins of cephalon partly cleft.

i. Metasome composed of 5 segments.

Proidotea, Rac. and Sev.

Mesidotea sibirica (Birula), em. Collinge.

Pl. V, figs. 1-11.

Glyptonotus entomon, Hansen. Dijmphna-Togtet, 1887, p. 188, T.xx, f. 1, 1*b*.

——— *sibiricus,* Birula. Ann. Mus. Imp. Acad. Sci. St. Petersb., 1896, i, p. viii.

(?) *Mesidotea sibirica,* Racovitza and Sevastos. Arch. Zool. exp. et gén., 1910, xlvi, p. 195.

[1] According to Miss Richardson, but I very much question the accuracy of her figures (8, p. 41, fig. 13*a*. & *b*.). The short, first joint is not shown, and I know of no genus or species of this family in which it is absent, or where the basal plate (basipodite) and epipodite are united.

Body (fig. 1) oblong oval, convex dorsally, slightly wider anteriorly, narrowing beyond the 4th mesosomatic segment. Cephalon (fig. 1) elongate, deeply excavate between the lateral lobes, with small median excavation also, on either side of which is a rounded eminence. Margins of lateral lobes cleft, divisions almost subequal, the anterior one being rounded in outline and the posterior one more acute. Eyes distinct, small and round, situated dorsally, lateral to the eminences bounding the median excavation of the anterior margin. Faintly marked posterior transverse furrow. Antennulae (fig. 3) with the 1st joint expanded and somewhat conical, 2nd joint small, 3rd joint longer, and wider distally; flagellum elongated single joint, with numerous spatulate setae and longer terminal setae. Antennae (fig. 4) extending to the postero-lateral border of the 1st mesosomatic segment; 1st joint very small, 2nd, 3rd and 4th joints expanded, and almost subequal; 5th joint elongated and slightly keeled on the dorsal side; flagellum with 9-10 joints and short terminal style. First maxillae (fig. 5) stout, outer lobe terminating in ten stout, curved spines, setose on the inner lateral margin; inner lobe terminating in three setose spines, and two setules on the ventral face. Maxillipedes (fig. 6) short and broad, basal plate thickened, short and almost square, palp 5-jointed, epipodite almost circular, with closely set fringe of fine setae on the anterior and outer border, inner distal lobe thickened, terminally sloping inwards, with plumose setae terminally. Segments of the mesosome (fig. 1), excepting the 1st, almost subequal, 1st with widely expanded pleural plates which flank the cephalon, anterior angle rounded, posterior acutely pointed. Coxal plates (fig. 1) well developed on the 2nd to 7th segments, smallest on the 7th, posterior angles acutely pointed and directed backwards. Thoracic appendages (figs. 7-9), 2-4 small and directed forwards, 5-8 considerably larger and directed backwards. Metasome (figs. 1 and 2) composed of five segments, 1-4 short, terminal segment elongated, with lateral margins slightly incurved anteriorly, beyond the middle expanded and then tapering to an obtuse, upturned point; anteriorly the terminal segment has a somewhat prominent median boss, and two smaller lateral ones. Uropoda (figs. 10 and 11) small, wider anteriorly than posteriorly, with strongly marked, raised longitudinal line towards the inner border, endopodite obtusely pointed, exopodite very small, situated on the inner side.

Length 79 mm., width 30 mm. Colour (in alcohol) yellowish-brown.

Habitat.—Kara Sea.

Remarks.—This interesting species may at once be separated from either *M. entomon* (Linn.) or *M. sabini* (Kröyer) by the shape of the cephalon and antennae, it further differs from *M. sabini* in the form of the 1st maxilla and maxillipedes. In this species the inner lobe of the 1st maxilla has three setose spines and two setules, whereas in *M. sabini* there are only two spines and one setule. In neither *M. entomon* or *M. sabini* are the lateral lobes of the cephalon so well developed as in *M. sibirica.*

Birula (1) mentions that his specimen was 70 mm. long and 28 mm. wide.

Hansen's figure of the maxillipede is, I believe, slightly inaccurate, in that it shows the coxopodite as a single large division at the base of the basipodite and epipodite, and a very small lateral nodule on the inner margin. In the specimen I have examined, the epipodite articulates with the large outer division of the coxopodite and the basipodite with a smaller inner division (Pl. V, fig. 6).

The appendages (2-8) of the mesosome readily lend themselves for separation into two distinct sets, viz., those of segments 1-3, which are small and directed forwards, and those of segments 4-7, which are considerably larger and directed backwards.

The segments of the mesosome are almost smooth; they are marked by numerous tiny pits and are fairly convex throughout. Laterally there is a raised boss on each side, and one in the median line on the four anterior segments. The pleural plates of the 1st segment partly flank the cephalon, their anterior margin is rounded, and the posterior angle pointed. The coxal plates are large and occupy the whole of the lateral margins; those on segments 2-4 are rounded in front and posteriorly produced backwardly as a sharp spine, those of segments 5 and 6 are more cut away anteriorly and have the spines more produced; the spines of the seventh segment are similar in shape, only much smaller.

BIBLIOGRAPHY.

1. BIRULA, A.—Sur la collection des évertébrés de Mr. A. Botkine. Ann. Mus. Zool. l'Acad. Imp. Sci. St. Petersburg, 1896, T. i, pp. vii-ix. [In Russian].

[1] 2. EIGHTS.—Trans. Albany Instit., 1833-52, vol. ii, p. 331, pls.—also Amer. Journ. Sci. and Arts, 1856, vol. xxii, p. 391, pls. ii, iii.

3. HANSEN, H. J.—Oversigt over paa Dijmphna-Togtet indsamlede Krebsdyr. Dijmphna-Togtets zool.-bot. Udbytte, 1887, pp. 185-286, pls. xx-xxiv.

[1] Not seen. *Vide* Miers 6.

4. HARGER, OSCAR.—Descriptions of new Genera and Species of Isopoda from New England and adjacent regions. Amer. Journ. Sci. and Arts, 1878 (s. 3), vol. xv, pp. 373-379.

5. KRÖYER, H.—Karcinologiste Bidrag. Naturh. Tidsskr., 1846-49 (s. 2), vol. ii, pp. 1-123, 366-466.

6. MIERS, E. J.—Revision of Idoteidae, a family of Sessile-eyed Crustacea. Journ. Linn. Soc. Lond. (Zool.), 1881, vol. xvi, pp. 1-88, pls. i-iii.

7. RACOVITZA, E. G., AND SEVASTOS, R.—*Proidotea haugi*, n.g., n.sp., Isopode oligocène de Roumanie et les Mesidoteini nouvelle sous famille des Idotheidae. Arch. Zool. exp. et gén., 1910, vol. xlvi, pp. 175-200, pl. ix, x.

8. RICHARDSON, HARRIET.—Isopoda collected in Japan in the Year 1900 by the U.S. Fish Commission Steamer Albatross, etc. Proc. U.S. Nat. Mus., 1904, vol. xxvii, pp. 32-45, 21 figs.

9. ——— A Monograph on the Isopods of North America. Bull. No. 54, U.S. Nat. Mus., 1905.

10. SARS, G. O.—Prodromus descriptionis Crustaceorum et Pycnogonidarum quae in Expeditione Norvegica anno 1876 observavit G. O. Sars. Arch f. Math. og Naturvid., 1877, vol. ii, pp. 237-271.

11. ——— Crustacea et Pycnogonida nova in itinere 2 dv et 3 tio Expeditionis Norvegicae anno 1877 & 1878 collecta (Prodromus descriptionis). Ibid., 1880, vol. iv.

12. ——— The Norwegian North-Atlantic Expedition, 1876-1878. Zoology, Crustacea, I, 1885, pp. xiv, 1*a*, 1*b* + 280, pls. 1-21 and map.

13. SAY, THOMAS.—An Account of the Crustacea of the United States. Journ. Acad. Nat. Sci. Phila., 1818, vol. i, pt. 2, pp. 393-401, 423-433.

14. STIMPSON, WILLIAM.—Synopsis of the Marine Invertebrata of Grand Manan, or the region about the Bay of Fundy, New Brunswick. Smithsonian Contrib. to Knowledge, 1853, vol. vi, pp. 39-44.

DESCRIPTION OF PLATE V,

Illustrating Dr. Walter E. Collinge's paper "On the Structure of the Marine Isopod *Mesidotea sibirica* (*Birula*)."

Mesidotea sibirica (Birula), em. Cllge.

Fig. 1. Dorsal view of male. × 1.

Fig. 2. Lateral view of metasome. × 1.

Fig. 3. Left antennule, dorsal side. × 3.

Fig. 4. Left antenna, dorsal side. × 3.

Fig. 5. Ventral side of the terminal portions of the inner and outer lobes of the left 1st maxilla. × 20.

Fig. 6. Ventral side of the left maxillipede. × 6.

Fig. 7. Ventral side of the 2nd thoracic appendage. × 4.

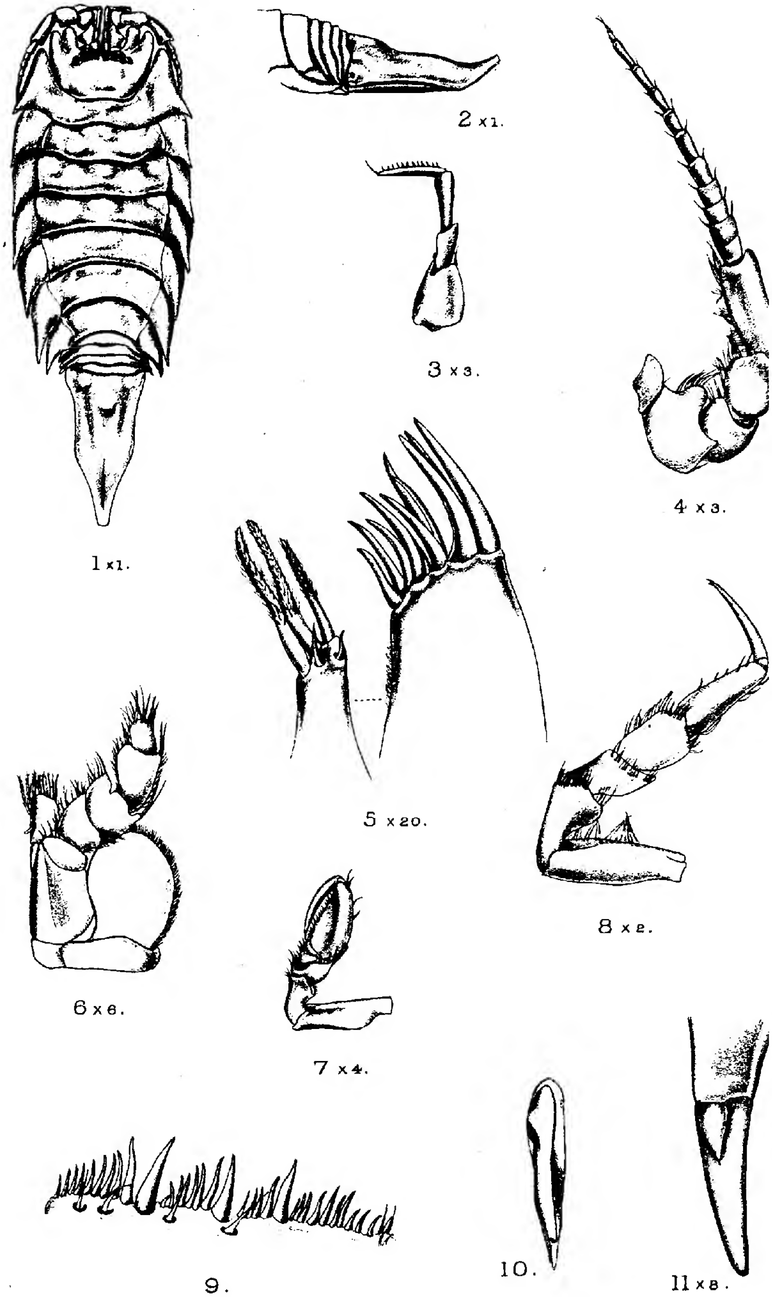
Fig. 8. Ventral side of the 8th thoracic appendage. × 2.

Fig. 9. Spines on the protopodite of the 2nd thoracic appendage, greatly enlarged.

Fig. 10. Right uropod.

Fig. 11. Portion of the left uropod seen from the inner side and showing the exopodite. × 8.

I desire to express my thanks to the Executive Committee of the Carnegie Trust, for a Grant to defray the artist's charges for the above figures.



H.G.K. del ad nat. Huth, Lon[d]

MESIDOTEA SIBERICA *(Birula)*.

A NOTE ON THE MARINE ISOPOD *IDOTEA ELONGATA*, MIERS.

By WALTER E. COLLINGE, D.Sc., F.L.S.,
Research Fellow of the University of St. Andrews.

THE Isopod which forms the subject of this note was named by White[1] in 1847, but no description was given of it. Miers[2] in 1876 was the first to describe it, and in his emended and later description in the "Revision" of the family in 1881,[3] he placed it between *Paridotea ungulata* (Pallas) and *P. peronii* (M. Edw.).

In 1884 Thomson[4] described and figured the female under the name of *Edotia dilatata*, and Chilton[5] in 1889 in his *Revision of the New Zealand Idoteidae* added some further notes.

Some little time back Professor Chilton very kindly forwarded to me four specimens of this species from New Zealand, and in examining the oral appendages I find, firstly, that the palp of the maxillipedes is 5-jointed and not 4-jointed as in the genus *Idotea*, Fabr., and, secondly, that the metasome is composed of a single segment and a suture, whereas in *Idotea* there are three segments and a suture.

It may be mentioned that of the genera in the family Idoteidae which possess a 5-jointed palp of the maxillipedes, *Mesidotea*, Richardson, has the metasome composed of four segments and one suture, *Pentidotea*, Richardson, has three segments and a single suture, *Zenobiana*, Stebbing, three to five segments, *Glyptidotea*, Stebbing, and *Pentias*, Richardson, each have a single segment and three sutures, *Engidotea*, Barnard, two segments and two sutures, *Cleantiella*, Richardson, two segments only, and *Crabyzos*, Spence Bate, is described and figured as having a single segment.[6]

In the majority of these genera the inner lobe of the 1st maxilla has three setaceous spines (*Engidotea* is described as having only two, those for *Cleantiella* have not been described).

Seeing that no other genus of the family possessed the 5-jointed palp of the maxillipede and a metasome composed of a single segment and a suture, it seemed necessary to erect a new genus to contain Miers' *I. elongata*, and this I had, in MS., done.

[1] List Crust. Brit. Mus., 1847, p. 95.
[2] Ann. Mag. Nat. Hist., 1876 (s. 4), vol. xvii, p. 225.
[3] Journ. Linn. Soc. Lond., 1881, vol. xvi, p. 54.
[4] Trans. New Zealand Inst., 1884, vol. xvi. p. 235, pl. xii.
[5] Ibid., 1889, vol. xxii, p. 198.
[6] Proc. Zool. Soc. Lond., 1863, p. 504, pl. xli, f. 7.

[JOURN. ZOOL. RESEARCH, October, 1916, vol. i, No. 3.]

Since then Mr. Walter H. Baker, F.L.S., has very kindly sent me a small collection of South Australian Idoteas, amongst which there are a number of specimens of *I. elongata*, a male example of *Crabyzos longicaudatus*, Spence Bate, and examples of a new species belonging to the last-mentioned genus.

In examining the oral appendages of *C. longicaudatus* and the *C.* n.sp., it was at once seen that there was a close resemblance in the form of the maxillipede to that found in *I. elongata*. Further, when I came to examine the two species of *Crabyzos* in greater detail, I found that the metasome had a very distinct suture at the base of the terminal segment, and in other structural details they showed a close relationship to *I. elongata*, which undoubtedly belongs to the genus *Crabyzos*. The new species is more closely related to *C. elongatus* (Miers) than is *C. longicaudatus*.

In another paper I am figuring and describing the external structure of the three species in detail.

NOTES ON THE VARIATION OF SOME BRITISH TERRESTRIAL ISOPODA.

By WALTER E. COLLINGE, D.Sc., F.L.S.,

St. Andrews University.

In common with nearly all other orders of animals, woodlice are found to vary from one another to a greater or lesser degree. This variation may be in size, shape or colour, and may be purely local or geographical.

Variations in size are comparatively rare, as also those showing structural differences. The varieties *aubini*, Cllge., and *darwiniana*, Bagnall, of *Porcellio scaber.*, Latr., are good examples exhibiting slight structural variations.

Variations in the antennae are fairly common, but I have satisfied myself that these are frequently due to injury.

Colour variations are exceedingly numerous, and, with a few exceptions, are not permanent during the life of an individual. In the early spring, at the foot of the East cliffs at St. Andrews, Scotland, and just above high-water mark, a very beautiful metallic blue variety of *Porcellio scaber* occurs, but as the season progresses this colour entirely disappears; further, if these coloured forms are removed from their habitat and kept in confinement or placed elsewhere, the colour disappears in from 16 to 24 hours.

Many colour variations depend largely upon the nature of the food, whilst others, I believe, are purely seasonable or due to environment.

Some colour variations seem common to certain species wherever they are found, *e.g.*, the varieties *rosea* and *flava*, Bagnall, of *Philoscia muscorum* (Scopoli), and the var. *marmorata*, Brandt., and *rufescens*, Cllge., of *Porcellio scaber*, Latr.

Whilst it is not desirable that evanescent colour variations should receive distinct names, it is obvious that all well-marked and permanent variations should. Those here described are a few that have been met with during the past year.

The author would welcome examples of any species of woodlice from all parts of the British Isles, in order to complete the Record of Distribution in connection with his monograph on these interesting crustaceans.

[Journ. Zool. Research, October, 1916, vol. i, No. 3.]

Ligia oceanica (Linn.).

Var. *flavescens*, nov.

Whole of body a deep yellow.

Loc.—Is. of Wight, Ryde—June, 1914! H. Overton. Fife—St. Andrews, 1915!

Trichoniscus pusillus, Brandt.

Var. *intermedius*, Bagnall.

It is questionable whether this is a variety or merely a malformation. Bagnall states "Peduncle not spined, flagellum composed of 5-7 joints."

Specimens of this species received from Dr. W. T. Elliott, from Tanworth-in-Arden, Warwick, in some cases exhibited both flagella with 6 or 7 joints, but more often the increased number was present on one flagellum only, and usually that of the right side. In a like manner the spines on the peduncle were sometimes absent, but more often present.

Trichoniscus roseus (Koch).

Var. *flavus*, nov.

Whole of animal a deep orange-yellow.

Loc.—Cheshire—Hale, 1915!

Oniscus asellus, Linn.

Var. *albidus*, nov.

Whole of animal a dirty-white and without any markings.

Loc.—Fife—St. Andrews, Jan. 1915!

Philoscia muscorum (Scopoli).

Var. *nacrum*, nov.

A pearly-white with a few fine, faint, irregular brownish markings.

Loc.—Is. of Wight—Brightstone, July, 1916! Mrs. C. M. Brown.

Var. *violaceum*, nov.

Ground colour of dorsal surface violet, with darker coloured median longitudinal band.

Loc.—Channel Isles—Guernsey, May, 1913! J. H. Webb.

Porcellio scaber, Latr.

Var. *rufescens*, Cllge.

Journ. Econ. Biol., 1913, viii, p. 14.

A deep yellowish-brown dorsally, ventrally a pale yellow; sparsely tuberculate, tubercles small.

Loc.—I have the following records :—

Lancashire—Marton, nr. Blackpool, July, 1915 ! Rev. S. G. Birks.

Stafford—Walsall, July, 1914 ! J. Ellis.

Worcester—Nr. Worcester, 1912 ! Tenbury, July, 1914 ! W. G. Banfield.

Is. of Wight—Brightstone, July, 1916 ! Mrs. C. M. Brown.

Channel Is.—St. Lawrence, Jersey, April, 1913 ! Miss M. Oxenden. Guernsey, May, 1913 ! J. H. Webb.

Fife—East Cliffs, St. Andrews, May, 1915 !

Forfar—Nr. Dundee, Aug., 1915 !

Var. *lateritius*, nom. nov. = *rufa*, Bagnall (*nec* Scott).

The name *lateritius* is proposed for the large, bright red variety, termed *rufa* by Bagnall in 1909, who evidently had overlooked the fact that Scott had previously used that name for a small rufous or brownish coloured variety.

Porcellio pictus, Brandt.

Var. *aureomaculatus*, nov.

Colour with a broken brown band in the mid-dorsal line, with brown and golden yellow mottling laterally, pleural plates light yellow, with few irregular brown markings. Cephalon a deep uniform brown, excepting the tips of the lateral lobes, which are faint yellow. Antennae with joints 1-3 mottled.

Loc.—Hereford—Cusop, nr. Hay, July, 1916 ! J. Williams Vaughan.

Yorkshire—Starbotton, nr. Sett[illegible]y, 1916 ! W. Denison Roebuck.

Lancashire—Heaton Mersey, Aug., 1916 ! R. Standen.

Derbyshire—Cavedale, Castleton, June, 1915 ! R. Standen.

Cylisticus convexus (De Geer).

Var. *patiencei*, nov.

Whole of body almost a pure white, with an irregular, narrow, dark brown, longitudinal median band, extending from the cephalon to the tip of the telson. Lateral portions of the mesosome with a few small dark brown patches.

Loc.—Two specimens from hothouse, Poplar Road, Lanark; one specimen from hothouse, Clachranehill, Ayr (A. Patience). One specimen from hothouse, St. Andrews !

This interesting variety was described by Patience in 1908 (Trans.

N.H. Soc., Glasgow, 1905-6 [1908], vol. viii, p. 86). I have seen a form approaching it from the Isle of Wight, and the variety as described above from St. Andrews. I have pleasure in associating with it the name of Mr. Alexander Patience, whose work on the Terrestrial Isopoda of Scotland has added so largely to our knowledge.

Armadillidium vulgare, Latr.

Var. *brunneoflavescens*, nov.

Whole of dorsum a light brownish-yellow.

Loc.—Is. of Wight—Freshwater Bay, March, 1916! Swanage, March, 1916! W. Omer Cooper.

Swanage—March, 1916! W. Omer Cooper.

Lancashire—Grange, Sept., 1909! R. Standen.

REVIEWS.

MEDICAL AND VETERINARY ENTOMOLOGY. By William B. Herms. Pp. xii + 393 and 228 text-figs. New York: The Macmillan Company, 1915. Price 17s. net.

This volume is an exhaustive treatise on the insects and arachnids which convey parasitic disease to man, and to some extent to other animals. It is very systematic, and is as "up-to-date" as any book can be which treats with a constantly changing subject. It is an eminently practical book, and without describing too many experiments it gives sufficient to indicate lines of research to observers who are in a position to investigate new arthropod-borne diseases.

The first fifty pages of the book deal with the structure and, to some extent, the habits of insects, the remaining three hundred and thirty pages deal with insects and arachnids in relation to special diseases.

Being written by an American, American nomenclature naturally occurs throughout the volume, and American nomenclature is often weird and seldom graceful. For instance, the term "cone-noses" may be practical, but it certainly is not elegant. Again, few English entomologists would be able to say without deep thought what the "two-spotted corsair" is.

The last seventy-five pages of the book are occupied with the arachnids. The arachnids of course belong to the same great phylum as the insects, but it is very difficult indeed to find a common feature which does not occur in other arthropods. I have tried again and again to find such a feature, because, if found, one would invent a word with a lot of Greek in it which would denote arthropods conveying disease to man and other animals, but so far my efforts have been fruitless.

This book may be confidently recommended to anyone interested in the control of insects or arachnid-borne disease. It has, however, one disadvantage. The majority of the illustrations are taken from photographs. Now nothing is so deceptive as photography, nothing is more easily "faked," and many of the figures of this book are worse than useless in endeavouring to identify a species of insect. Many of them are even difficult to recognize as insects. The number of these smudged photographs is too numerous to mention. One hopes and expects this book will reach the second edition, and in that case one begs that these blurred images may be replaced by adequate and helpful drawings. In conclusion, we may say that the book is furnished with an admirable index.

A. E. SHIPLEY.

A Manual of Mendelism. By James Wilson. Pp. 152. London: A. & C. Black, Ltd., 1916. Price 2s. 6d. net.

Professor Wilson's little book on Mendelism is designed on lines not dissimilar to those of other works introductory to the same subject. It begins with a brief account of Mendel's experiments, and goes on to discuss the complications which have arisen through more recent research. The examples do not strike us as always well chosen. For instance, in treating of "inseparable effects," where the manifestation of a given character depends upon more than one factor, the choice of the well-known case of the fowl's combs was right and proper. But to use the coat colours of mice and rabbits as further illustrations of the same point is surely a mistake. For the various "agouti" classes can easily be separated from the "non-agouti" classes by inspection, as can the various "blue" classes from the "non-blue" classes, or again, the different "chocolate" classes from the "blacks." The series of coat colours depends upon the co-operation of several factors, but in any combination the effect of each factor is readily separable from that of the others.

Those acquainted with Professor Wilson's writings know that he has been a steady opponent of the "Presence and Absence" hypothesis, holding closely to Mendel's original interpretation of the way in which a dominant character is related to its recessive. Which view is to be preferred is still an open question, and the matter has recently been brought forward prominently in connection with what the Americans term "Multiple Allelomorphs," and Professor Wilson "Polygamous factors." Briefly, there are cases known in which A behaves as a simple dominant to B, and also to C. Under such circumstances B mated with C would be expected to produce A. But in these cases B also behaves as a simple dominant to C. To Professor Wilson, and to Professor Morgan in America, belong the credit of having first drawn attention to these cases, and to suggest that factors might exist in groups of three or more, any member of a given group being allelomorphic to any other member of the group. The question was well discussed in Morgan's "Mechanism of Mendelian Heredity" (recently reviewed in this Journal), and we think that Professor Wilson would have been better advised had he selected some of the instances there given instead of attempting to interpret the coat colours of horses in terms of "Polygamous Factors." For when he states that brown, black, and chestnut form such a series he must surely have overlooked Table 35 in the paper of Dr. Walther, quoted by him, where ample evidence is given for the production of brown from black and chestnut.

The chapter on coupling is scrappy and unsatisfactory, and the student who depended on it for his information would remain ignorant of some of the most important features of this series of phenomena. In discussing the work done in this country with sweet peas, some of the cases are given in which the F 2 formed by the mating A b and a B, produces mostly gametes of the types A b and a B, those of the types A B and a b being more or less rare according to the case dealt with.

But of the curious reversal that occurs when the mating is of the type A B and a b, and of its connection with the other type, nothing is said. Nor should a discussion of coupling to-day omit all reference to the remarkable and important work on *Drosophila* recently done in America. There are two errors in this chapter which we should like to see altered. The Cornish Indian game can hardly be described as a "black" breed; while in Campines surely silver and gold are the alternative characters, not black and gold, as the author states. If this is not sufficiently clear in the barred breeds one has only to turn to the laced and to the spangled.

However, we fancy that the author's main object is to emphasize the practical importance of Mendelian knowledge. The reader will find interesting accounts of Pearl's work on the inheritance of egg-production in fowls, and on what is known as to the heredity of milk-production in cattle. Some account also is given of the Svalöf experiments with cereals, but we notice with surprise that no mention is made of the far-reaching work of Professor Biffen in Cambridge. We regret this the more because it is one of the few instances in this country of the enlightened endowment of scientific research by a Government Department, and one that has already produced results of the first economic importance.

Altogether, we feel that although the student may reap profit from some of the discussions in the book, he ought not from its title to consider that it offers him an adequate summary of the present state of Mendelian knowledge. For this it certainly does not.

R. C. PUNNETT.

THE FIRST PRINCIPLES OF EVOLUTION. By S. Herbert. Second (revised) edition. Pp. xii + 348 and 90 figs. London: A. & C. Black, Ltd. Price 7s. 6d. net.

This book is a serious attempt to put in accessible form not merely the principles of evolution, but with these the history of the evolution theory from early times. Not only are the phenomena expounded, but their explanation is discussed, and various views are criticised, so that we are never left in doubt as to the author's own ideas. This is, indeed, the only good plan to follow. We remember Huxley's caustic remarks on one type of text-book—"We are told that Professor Dickkopf maintains that the moon is composed of green cheese, but Professor Dummkopf holds that this is quite inconsistent with the new facts which he has since adduced"—such is my recollection of an address he gave at a prize distribution at University College, London.

The field explored is a very wide one; since it is necessary to give to the lay audience, for which the work caters, some idea of the facts before reviewing the theories based on them. The chapters include—Evolution in General; Inorganic Evolution, including Morphology and Embryology; Social Evolution, including Mental and Moral Evolution, and that of Society, the Family, the State and Religion; the Formula of Evolution, including Dissolution; and the Philosophy of Change.

Upon the last chapter, mainly an exposition of the fascinating, but to us still indistinct, synthesis of Bergson, we feel ourselves unable to pass judgment. The author would appear to accept it, although it is surely in contradiction with some of his own views. On the same ground of incompetence, we leave aside the chapter on Matter.

When we come to Evolution proper, and notably Embryology, we regret to find that there occurs such an instance of lack of real knowledge as to allow of the statement that once the morula stage attained, "*its central cells liquefy*, so that instead of a solid ball, we now get a hollow sphere." There is no emphasis laid on Experimental Embryology, if indeed the facts are mentioned: we have verified all entries of "Embryology" and "Embryogeny" in the somewhat meagre index, and have found no reference thereto. This is no mere carping: it is impossible adequately to judge, say, Driesch's views without realising the important basis of facts in that field which Driesch made so largely his own.

Apart from his inclination to Bergsonism, Dr. Herbert has too largely been influenced by what may be called the "orthodox" school of biologists. Thus no reference is made to the question of "Convergence" in determining the production of similar forms which must be admitted to possess a different ancestry. This omission is of capital importance in the discussion of orthogenesis. The discussion of vitalism suffers much from this defect. In the résumé of the evolution of life we find stated as facts what no well-informed biologist would accept as adequate. "A simple amoeba has no definite shape nor special organs, while its complexity is only one of degree." How about the nucleus? "The lowest organisms multiply by mere fission, as a drop of oil would do." How about the longitudinal fission of the Flagellates and the Spirochetes? "There are certain chemical compounds which are distinctive of the organism, for they are only to be found associated with the function of life, and never occur in inorganic nature, these are the proteids, the carbohydrates and the fats." I should be loth to affirm the absence of carbohydrates from inorganic nature, although I know of none: on the other hand, that most important group of organic ferments or "zymases" is omitted. "A special vital principle has been claimed by the adherents of vitalism for the phenomena of life." We can cite at least one such adherent, who declines to speak of a "vital principle," though he recognises "vital characters."

As with vitalism, so, from too exclusive a reading, Dr. Herbert is grossly unfair to Neo-Lamarckism. Kammerer's work on Amphibia is ignored; Butler, Henslow, Przibram, Hering, and Semon are not mentioned in the bibliography. On the other hand, Osborn is cited as explaining the structures of mammalian teeth and limbs by "the mechanical action of external agencies," whereas in this most recent work, at least Osborn has shown that new structures in the teeth are at first seen so minute as to be absolutely useless and functionless—a strong argument, by the way, for orthogenesis.

In the discussion of the mental processes of animals the pioneering

work of Von Osten, K. Krall, and Pauline Moekel, on thinking horses and dogs, is completely ignored. Yet the book is a good one in many ways. It is well written, well illustrated, and well printed. The layman who masters it will no doubt find on further reading that he has much to unlearn; but he will also have learned much that it will be profitable for him to know.

MARCUS HARTOG.

A BIBLIOGRAPHY OF BRITISH ORNITHOLOGY from the Earliest Times to the end of 1912. By W. H. Mullens and H. K. Swann. Pts. 1 and 2, pp. 240. London: Macmillan & Co., Ltd., 1916. Price 6s. net per part.

When Messrs. W. H. Mullens and H. K. Swann essayed the task of publishing "A Bibliography of British Ornithology" they made the initial and unfortunate mistake of deciding to distribute their laurel wreaths according to an arbitrary standard, and not according to merit. In this curious compilation, which is like the Curate's egg—"good in parts"—no one is accorded a place unless he has succeeded in securing a niche within a separate publication other than a serial magazine. No more than half a page of notes, included in a guide book, will suffice to secure him immortality! The authors are evidently sometimes even sorry for those who must be thus included. Thus they tell us of "Duck (John N.)." "The author does not appear to deserve mention as an ornithologist. The list is a very imperfect one, occupying not more than half a page"! But that half page compelled the authors to bring this defunct duck out of the oblivion into which a kindly Nature had taken him, because he had the misfortune to include it in his "Natural History of Portland."

Again they tell us of the Rev. C. A. Bury that, "strictly speaking, this writer of Bonchurch, I.W., seems to have no place here, his notes having been published in the 'Zoologist.'" That would apparently have damned them for all time, had not Mr. W. H. Davenport-Adams come to the rescue and printed then in his History; which "gives the author some claim to notice"! But having once gained favour the authors go "the whole hog," and record even the fact that he wrote a work on "The Church Association." This may be a very admirable work, but it does not seem to have even the remotest connection with British Ornithology!

So eminent an ornithologist as Dr. F. E. Beddard owes his place here to the fact that he wrote a "Chapter on Structure and Classification" for W. H. Hudson's *British Birds*, and a Preface to Tristam-Valentine's *London Birds and Beasts*. But for this it would never have been recorded to his credit that he contributed a paper to the "Proceedings of the Zoological Society," "On some anatomical differences between the Common Snipe and the Jack Snipe"!

It cannot be denied that the arbitrary standard of the authors in selecting their subjects is stupid. To this must be attributed the omission of Dr. Walter E. Collinge, who has done such valuable work

on Economic Ornithology in regard to British Birds; while it has compelled them, on their own showing, to include names which have no claim to mention.

Mr. Mullens is well known to us all, and we are grateful to him for the admirable services he has rendered to ornithology by his researches in regard to ornithology of more primitive times; and his contributions to this work will alone justify its publication.

W. P. Pycraft.

Notice sur les Glossines ou Tsétsés. Par E. Hegh. Londres: Hutchinson & Co. Pp. 148 and 29 figs.

This little volume by a Belgian agriculturist has been issued under the auspices of the Ministère des Colonies of the Royaume de Belgique, and is intended as the first of a series of studies in Agricultural Biology. It contains a great deal of carefully collated information drawn mainly from the works of Austen, and the numerous series of reports and papers published in the *Bulletin of Entomological Research*. It is evidently designed for use by the working entomologist in Africa, and the vast subjects of Sleeping Sickness and Nagana, with the associated Trypanosomes, are consequently not dealt with. Brief but concise descriptions are given of all the known species of the genus *Glossina*, and these are accompanied by original figures illustrating their relative sizes and the differences which are exhibited in the abdomen and the feet. We think, however, that the author would have done well to have made a fuller use of Newstead's work on the male external genital armature, which is of great value in deciding doubtful cases of specific identity. The distribution of the various species is dealt with, and is followed by a useful summary of what is known concerning their biology, metamorphosis, and feeding habits. Not the least interesting section of the work is the account given of the natural enemies of Tsetse flies. The recently discovered parasites belonging to the families Bombyliidae, Mutillidae and Chalcididae are enumerated and excellently figured. Full directions are given for the capture, rearing and preservation of Tsetse flies; instructions are also appended for dissecting out the salivary glands according to the method adopted by Mr. Lloyd of the Sleeping Sickness Commission. The examination of these organs is of great importance to specialists concerned with the transmission of Trypanosomes through the agency of these flies. The book concludes with an appendix, dealing with later information published since it was in type, and both subject and author indexes. The volume is not dated on its title page, which is an unfortunate omission; the copy before us bears the year 1915 on the publisher's cover, and this date has been added afterwards by means of the impress of some kind of stamp. It would have been an advantage also to have indicated the price of this handy little book. We shall look forward to the appearance of further volumes in this series, and if their standard is to be judged by the present work their utility and success should be assured.

A. D. Imms.

ON THE STRUCTURE AND BIOLOGY OF TACHARDIA LACCA, KERR, with observations on certain insects predaceous or parasitic upon it. By A. D. Imms and N. C. Chatterjee. Pp. 42, 8 plts. (2 coloured). Indian Forest Memoirs, Forest Zoology Series, vol. iii, part 1. Calcutta: Superintendent Government Printing, 1915. Price R. 2.22, or 3s. 6d.

In this Memoir we at last have a complete and satisfactory account of the remarkable insect that produces the lac of commerce. In fact, within the compass of 42 pages is what might be described as a monograph of the species, including historical notes, sections on the chemical composition of the lac and on the distribution of the insect in India, a list of 36 distinct plants upon which it occurs, a full and careful description of the structure and metamorphosis of the insect in its various stages, a detailed account of its various insect enemies, and, finally, a useful bibliography.

Of these various sections I feel qualified to comment upon those only that treat of the structure and metamorphosis of the insect. The egg, larva and adult insect (of both sexes) are described in the fullest detail, from direct observation, with the gratifying result that several long-standing errors in descriptions by previous writers have been corrected.

I had hoped that, possibly, our authors might have been able to throw some light upon the function of that interesting organ (the dorsal spine) which has no homologue in any other Coccid genus. But this puzzle still awaits solution.

On page 16 attention is drawn to the apparent transposition, during metamorphosis, of the anterior and posterior spiracles. It should be noted that this change is effected during the later development of the imaginal stage. Immediately after the second (and final) ecdysis, all the parts are found in their normal positions, and there is, at first, little to distinguish this from the previous stage, beyond the acquisition of the dorsal spine.

The memoir is illustrated by eight excellent plates, of which the first three are devoted to the structural characters of the insect. Plates IV to VI are reproductions of photographs, showing the appearance of the lac incrustations. The enlargement on Plate V is a remarkably successful picture of the fresh lac, showing the tufts of white filaments protruding from the apertures in the cells. Plates VII and VIII depict the principal insect enemies of *Tachardia lacca*.

The authors are to be congratulated upon the production of this useful piece of work.

E. ERNEST GREEN.

MODES OF RESEARCH IN GENETICS. By Raymond Pearl. Pp. vii + 182. New York: The Macmillan Company. 1915. Price 5s. 6d. net.

Of the five chapters of this book, three consist of papers recently published by Dr. Pearl, and now reprinted in slightly altered form. The first chapter is devoted to a critical examination of current modes

of research in genetics. The author holds that the purely statistical method of attacking the problem of heredity, as it has thus far been developed, has serious limitations, in that it deals only with the most superficial aspects of the problem. While realising the respective advantages of the biometric, Mendelian, cytological and embryological methods of enquiry, Dr. Pearl indicates their limitations and pleads for the addition of biochemical methods, to the armament of the investigator, instancing the great possibilities opened out by serological researches bearing on the most fundamental problems of genetics.

In his second chapter, on biometric ideas and methods in biology, the author defines the real purpose of biometry as the general quantification of biology. Biometry has therefore a legitimate application to many enquiries, being in last analysis a descriptive method. But to attain the highest type of result biometry must work in conjunction with the experimental method, and must be employed to describe and analyse the results in order to enable the most accurate conclusions possible to be reached. Dr. Pearl points out that biometry has shown the importance of the probable error concept, and that it has provided a method of measuring the correlation between characters. The limitations of the biometrical method must, however, be kept in mind, and for its valid employment sound biological intelligence must be used in regard to the applicability of a particular method to a given problem.

The author discusses in his third chapter the nature of statistical knowledge, and shows that the great value of the statistical method is that it can furnish a description of a group of objects in terms of the group's attributes rather than those of the individuals composing the group. It also enables one to draw certain conclusions regarding an individual from a precise knowledge of the group or mass. In both respects, and especially in the latter, it has its limitations, which the author clearly indicates.

In the fourth chapter the author surveys certain mathematical aspects of the problem of inbreeding. He points out that there seems not to have been worked out any adequate general method of measuring quantitatively the degree of inbreeding, and he proceeds to show how this may be expressed by a "coefficient of inbreeding." By mathematical treatment he shows that inbreeding, continued for some ten generations, "quite regardless of the type of mating, provided only it be continuously followed," leads to within one or two per cent. of complete "concentration of blood." The bearing of this and other results on the general question of the degree of inbreeding which exists in the ancestry of our domestic animals is discussed with the aid of two or three illustrative examples of pedigreed stock. The author's method of indicating the degree of inbreeding affords precise means of measuring, and hence of comparing, systems of mating.

In his final chapter the author discusses the relation between the science of genetics and the practical art of breeding. In his opinion animal breeding has, without the aid of genetic science, attained an extremely high level of achievement. The "trial and error" method,

in vogue during centuries, having brought practical breeding into rather close conformity with the basal laws of heredity, the discovery of some of these laws cannot radically change the animal breeder's way of attaining results, though it has now provided him with general working principles—a real contribution of science to practice.

The book will stimulate thought and enquiry, and may be read with profit by the geneticist and the breeder.

J. H. ASHWORTH.

REPORTS ON THE FOOD OF THE ROOK, STARLING AND CHAFFINCH. By F. V. Theobald and K. McGowan, and H. S. Leigh. Pp. vi + 56. Suppl. No. 15 to the Journal of the Board of Agriculture. London: 1916. Price 4d.

The desirability of a thorough and exhaustive inquiry into the subject of the food and feeding habits of certain species of British wild birds has long been realised, both by naturalists and by those connected with agriculture and horticulture. Such an inquiry, however, must, if it has to be of any practical value, be undertaken in a truly scientific and businesslike spirit, otherwise it is only a waste of time and money, and of very little service.

When in 1908 the Board of Agriculture decided to join hands with the British Association on this question, we were very dubious if any really practical gain would result from their proposed inquiry, and, after a lapse of eight years, we have before us a report dealing with the food of the rook, the starling, and the chaffinch, which adds little or nothing to our previous knowledge.

The Board have been particularly unfortunate in the manner in which they have dealt with this subject. So long ago as 1906 they pointed out "that an accurate inquiry into the habits and food of birds was much needed, especially into the assertions that these habits are undergoing a change in consequence of the changing conditions in which the wild life of England is placed," and in 1908 they published Mr. Newstead's report. So far as the questionable species were concerned this paper afforded little assistance, as the number of specimens examined was, in most cases, far too small. An interim report on the food of the rook was issued in 1914, and that now before us forms their third contribution to the subject. Originally commenced by Mr. Hewitt, the work was later passed on to Mr. H. S. Leigh, and still later Messrs. Theobald and McGowan have undertaken part of it.

Messrs. Theobald and McGowan, after examining 277 rooks, 748 starlings, and 527 chaffinches, state that from the gizzard contents "the rook is thereby shown to be very harmful. On the other hand, the starling has been shown to be most helpful. In regard to the chaffinch the writers do not feel entitled to express a definite opinion." Mr. Leigh, after examining 209 rooks, 486 starlings, and 357 chaffinches, seems unable to pronounce a definite verdict.

After a very careful consideration of this report, we fail to see, so far as any practical gain is concerned, that it has added to the investi-

gations of and the results obtained by Hammond, Collinge, and Florence.

If further species are to be investigated (and if the rate of three every eight years is maintained, the progress will be very slow and extremely costly), we trust that they will be undertaken in a very different manner. In an investigation of this kind it is not enough to examine the food contents of the gizzards of adult birds. Even in this country economic ornithology has progressed beyond that stage. Useful as such details are, they are quite insufficient to enable one to arrive at any reliable conclusion respecting the economic status of any species of wild bird, and seeing that much more detailed information already existed respecting the three species of birds dealt with in the report under consideration, to duplicate part of such is, in our opinion, largely a waste of time, and certainly a waste of public money. Economic ornithologists, and all connected with agriculture and horticulture, cannot fail to be very disappointed with the Board of Agriculture's efforts in this important subject.

WALTER E. COLLINGE.

The Journal of Zoological Research.

Vol. 1. DECEMBER, 1916. No. 4.

Contents.

THE

JOURNAL OF ZOOLOGICAL RESEARCH.

AMPHIPODA MONTAGUI (M.-EDWARDS) = *ISAEA MONTAGUI*, M.-EDWARDS. A STUDY IN CLASSIFICATION.

By H. CHAS. WILLIAMSON, M.A., D.Sc.,
Marine Laboratory, Aberdeen.

WITH 29 TEXT-FIGURES.

THIS amphipod was found on lobsters caught at Garvelloch, on the West Coast of Scotland, on October 3rd, 1913. Its presence had been noticed by the lobster fisherman, and he directed my attention to it. One or more examples were found on almost every lobster, which was captured on that date, even on a lobster which I think had cast recently. Two lobsters which had cast recently, harboured however none of these parasites.

The parasites lurk about the maxillipedes, and also in the middle line of the ventrum of the thorax.

This species has all the pereipods chelate; these appendages are all of approximately equal size. The antennules were reddish, and the skin of the animal had, when dry, a metallic sheen.

It has been described by several authors, first by Milne-Edwards (7), then by Bate and Westwood (2), and by Della Valle (11).

The adult is illustrated in the following figures, which are not all drawn to the same scale. All the spines are not introduced into every drawing.

In describing the appendages I make use of one of the terminologies employed for decapod Crustacea. Some authors have named the three pairs of maxillipedes of the amphipod as a first pair of maxillipedes, and a first and second pair of gnathopods. It is difficult to see what advantage is gained by using the greek name for the second and third pairs, and the latin for the first pair.

One does not describe the appendage of the species, but the appendage of the individual specimen of the species.

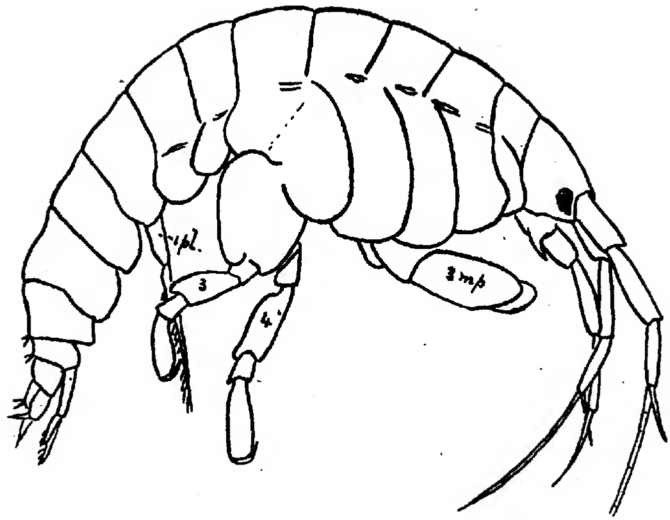


Fig. 1. Adult Female.

This figure is intended to show the relative sizes of the segments and appendages. The specimen measured in greatest over-all horizontal dimension 6 mm. The dotted line on the 5th plate indicates a prominent line that appeared on that part of the specimen: it was, I think, a wrinkle or fold. There are a few hairs on the dorsal surface of the hind segments. For details of the lower edge of the 7th—10th lateral plates see Fig. 21.

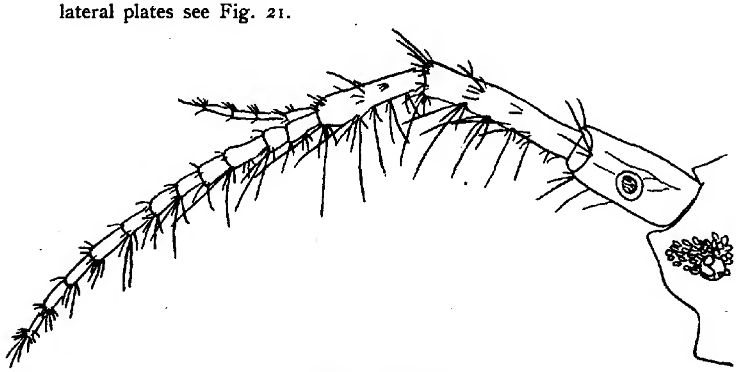


Fig. 2. Antennule.

The antennule consists of three basal segments and two flagella. The number of segments observed in the flagella were as follows :—

In female specimens	short flagellum 4, 5. long flagellum 7, 9, 10, 11, 12, 13.
In male specimens	short flagellum 4, 6. long flagellum 10, 11.
A large specimen (male ?)	short flagellum 3, 5. long flagellum 9.
Small specimens (sex ?)	short flagellum 1, 2, 3. long flagellum 3, 5, 9.

Two very small specimens had 1 and 3 segments in the short and long flagella respectively.

Sometimes the number of segments in the flagellum differed on the two sides of the animal, *e.g.*, the small branch showed the following cases of divergence, 3 and 5 : 4 and 5 : 4 and 6; while the long flagellum showed 10 and 11 : 7 and 13.

Aesthetascs (sensory hairs) were present on the distal borders of the 2nd to 10th segments of the long flagellum—a long one on the second segment, and a long and a short one on the 3rd to 10th segments. In the antennule of a second specimen an aesthetasc was present on the distal border of the 1st segment. Many of the hairs were serrated.

When examining the antennule and antenna it is difficult to tell whether or not a segment or two may have been broken off. In some cases spines and aesthetascs show branches rising from them : these may sometimes be filamentous algae.

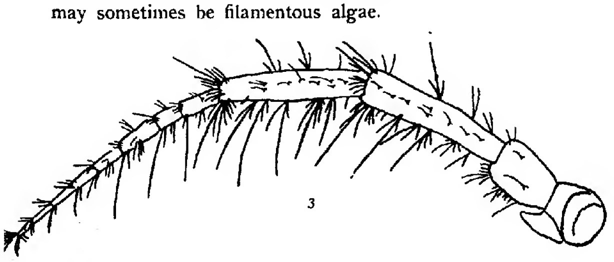



Fig. 3. Antenna. Fig. 4. Spines of antenna.

The antenna has four basal segments, and a series of short segments forming the flagellum. The number of segments observed in the flagellum were—in ♀ specimens, 6-9 : in ♂ specimens, 8, 9 : ? ♂ specimen, 9 : small specimens (? sex), 3, 6, 7. Sometimes the flagellum on one side had a different number of segments from that of the flagel-

lum of the other side, *e.g.*, 9 and 8: 7 and 6. No aesthetasc was noticed. Some of the spines on the lower surface (in the drawing) are omitted. Most of the spines are double pointed. Fig. 4 shows the tip in certain of the larger spines. There are one or two short plumose hairs.

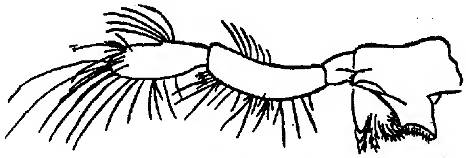


Fig. 5. Mandible.

All the spines of the apex of the palp are not shown. Many spines are serrated, and some have cleft tips, but slightly different from those of the antenna.

Fig. 6. First maxilla, female.

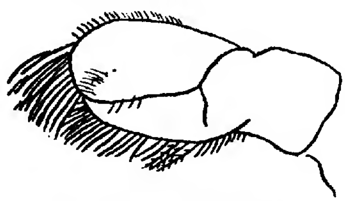


Fig. 7. Second maxilla, female.

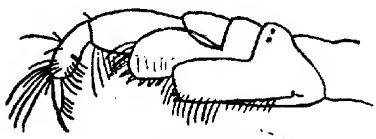


Fig. 8. First maxillipede.

Many spines are serrated. No attempt was made to introduce the correct number of spines into the drawing. A large number of spines of the 5th segment is hidden by the plate of the 3rd segment.

Fig 9. Second maxillipede, female.

The spines are arranged in comb-like groups. All of them have not been introduced into the drawing. Many are serrated. I did not notice any distinct bifurcation of the tip of the spine.

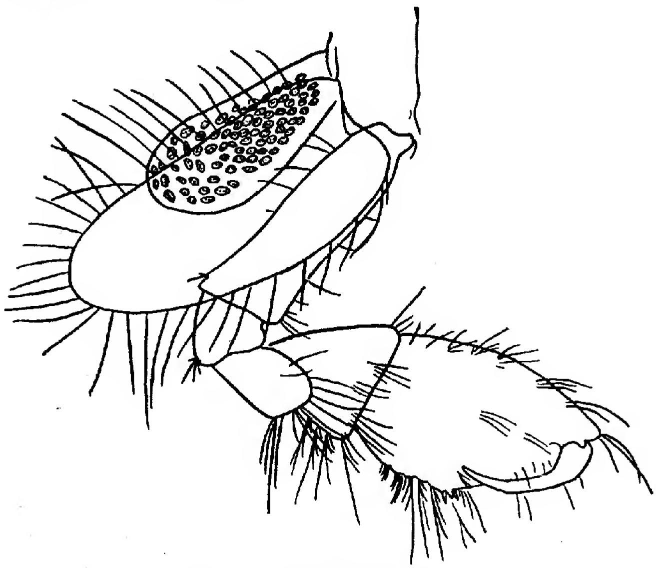


Fig. 10. Third maxillipede, female.

The large hair-encircled sheath is one of the plates that form the egg-pouch.

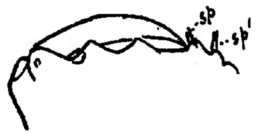


Fig. 11. Third maxillipede, female. Edge of propodus.

The edge of the propodus bears three large triangular teeth and two short bifid spines, *sp.* and *sp*[1].

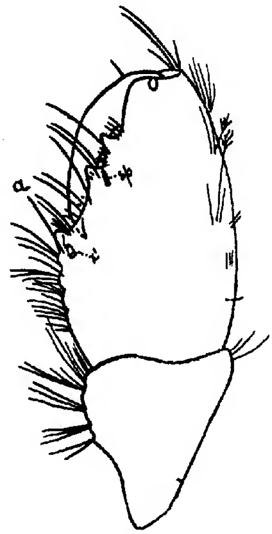


Fig. 12. Third maxillipede, male.

At the place corresponding to the location of *sp.* in the preceding figure, I observed a longer and thinner spine. I saw no real counterpart of *sp.*[1], but a prominence at x^1. Both x^1 and *sp.* of this figure are on the under side of the drawing. Many of the spines on the side next *a* have bifid tips. On the opposite side some are serrated, and there are some hairs with many branched tips.

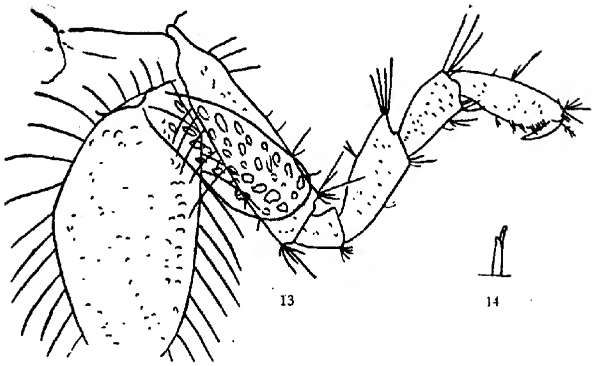


Fig. 13. First pereiopod. Fig. 14. Tip of Tooth.

The teeth round the chela have bifid tips (Fig. 14).

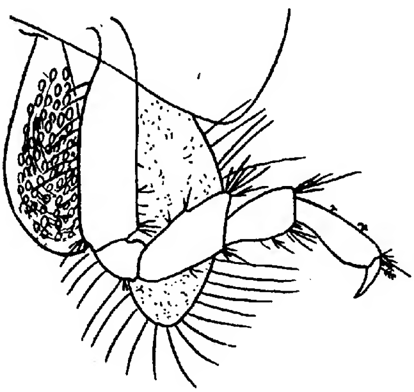
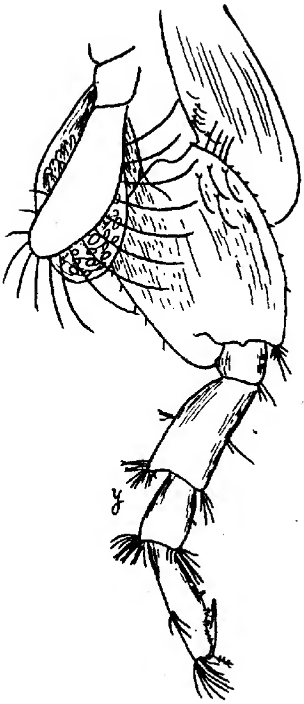
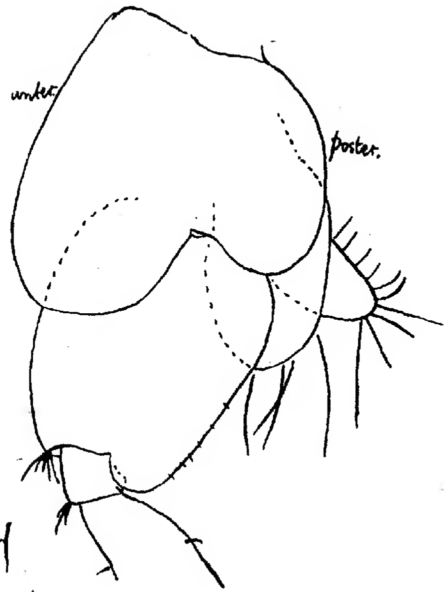


Fig. 15. Second pereiopod, female.



16

17



18

Fig. 16. Third pereiopod, Fig. 17. Tooth. Fig. 18. Fifth lateral plate.

There are many double-tipped spines on the side next *y*. Fig. 17 is a tooth on the chela-surface of the propodus. The 5th lateral plate was in one specimen tucked under the edge of the 4th plate on one side, and was above the edge of the 4th plate on the other side. In another specimen, the hind edge of the 5th plate was under the edge of the 6th plate.

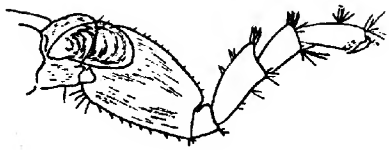


Fig. 19. Fourth pereiopod, female.

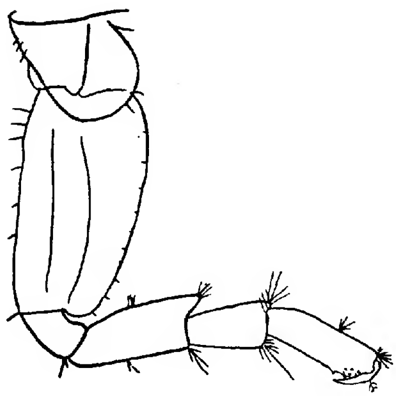
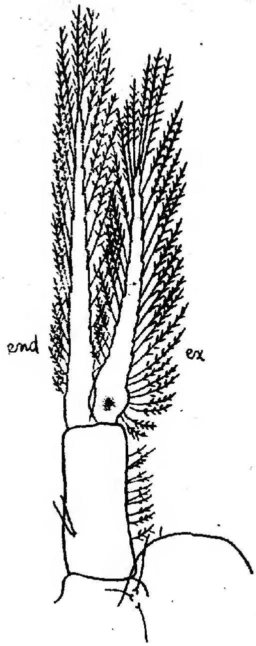


Fig. 20. Fifth pereiopod.

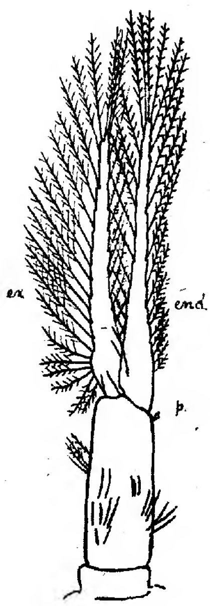
Some of the spines are bifid at their tips.

Fig. 21. Seventh to tenth pleural plates.

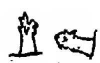
The 7th plate is part of the 5th pereiopod. The 8th, 9th, and 10th plates belong to the segments bearing the 1st, 2nd, and 3rd pleopods respectively. On the hind margin of the 8th, 9th, and 10th plates there is a rounded tooth: on the 7th plate there is a slight nick. In each angle there is a short hair. The tooth on the 10th plate is the most prominent, and in one specimen it was somewhat sharp-pointed. Fig. 22 agreed with certain male and female specimens.



22



23



24

Fig. 22. First pleopod, female; *end.*, endopodite; *ex.*, exopodite.
Fig. 23. Second pleopod, female. Fig. 24. Hooked pillar.

The 3rd pleopod resembles the 2nd very much : both are provided with the hooked pillar (*p.* Fig. 23 and Fig. 24). These pillars may be for binding the pair of pleopods together.

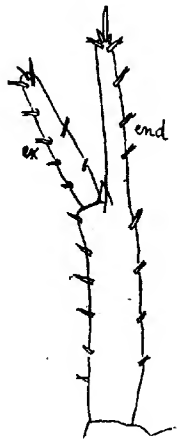


Fig. 25. Fourth pleopod.

Some of the spines have bifid apices. The 5th pleopod is shorter than the 4th, but it resembles it in general structure.

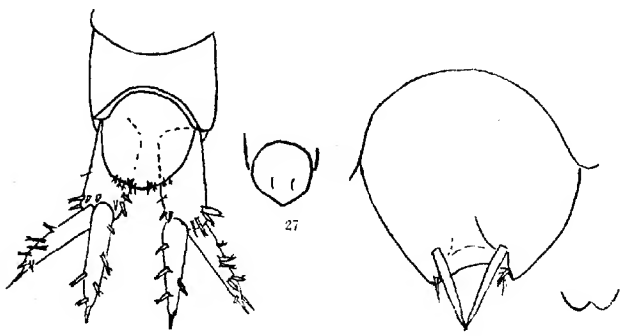


Fig. 26. Uropods and Telson, female. Fig. 27. Telson, male. Fig. 28. Telson of specimen of about half of adult size. Fig. 29. Telson, female, hind edge.

The telson exhibits different shapes: it may be rounded, pointed, or notched posteriorly. The rounded form was observed in Fig. 26 and in a very small specimen. The position of the spines on the telson in Fig. 26 might indicate that the view of the telson here shown was not a quite vertical one, it may be that the hind margin is hidden. In

two small specimens a notch was observed : a third small form did not exhibit the notch. In a ♀ the tip of the telson was nicked a little (Fig. 29). In both a ♂ and a ♀ the telson had the form shown in Fig. 27. A notch was observed in the small specimen (Fig. 28).

Sex distinctions were found only in the presence of the setose egg-plates in the ♀, and their absence in the ♂, and in the armature of the 3rd maxillipede. The presence of the eggs or larvae in the incubatory pouch is of course a useful aid in detecting the ♀. The hand of the third maxillipede of the ♂ is little, if at all, larger than that of the ♀.

This species was first described and figured by Milne-Edwards (6 and 7). It has since been described by Bate (1) and Della Valle (11). The first and third descriptions differ in one or more points from that which I have given above.

In Edwards' (7) figure the fifth epimeral plate is shown much narrower dorso-ventrally than the fourth plate : the antennule is, moreover, shorter than the antenna. Edwards says that the antennule is nearly of the same length as the antenna.

Della Valle's figure of the complete animal does not distinctly show the first two pereiopods chelate, although these appendages are described by him as chelate. The telson exhibits no hairs nor spines attached. The third maxillipede is shown with four huge teeth as the cutting edge of the propodus, whereas Edwards describes three, and I have found three. Della Valle (11) says that the long flagellum of the antennule is about as long as the peduncle, and is composed of sixteen segments : the short flagellum is composed of six segments. The flagellum of the antenna is composed of a dozen segments. None of the Garvelloch specimens had more than thirteen segments in the long flagellum of the antennule, nor more than nine in the antenna. The following data are also given by Della Valle. Length, 5 mm. : the rosy-yellow colouration is not uniformly distributed on the body, but is rather disposed in zones in the middle of the single segments and of the epimera, much less on the other appendages. The antennae alone have a somewhat uniform tint : the eyes are crimson : the epimera of the 2nd and 3rd maxillipedes and thoracic feet of the middle group are as high as the corresponding segments : the antennule is a little longer than the antenna : the telson ends posteriorly in a prominent acute angle.

According to Bate and Westwood, the eyes are of a bright red colour; the telson looks more like a small segment of the animal than is usual : it is cylindrical and surmounted by a small spinule.

Notwithstanding the discrepancies between the accounts of the

different describers, I think we are dealing with one species, viz., the *Isaea montagui* of Milne-Edwards.

Bate and Westwood found all their specimens of this species on the back, or in the branchial chamber of *Maia squinado*: they seemed indeed to exist among the thick stiff hair on the carapace of this spider-crab as if they were in their accustomed habitat, their prehensile legs being peculiarly adapted for holding themselves on that animal. Chevreux (4) often found 30 to 40 specimens of the parasite on a single *Maia*.

I examined a number of edible crabs (*Cancer pagurus*) landed at Aberdeen in October, but I found none of these parasites on them.

I do not know how far the parasites may be commonly present on the lobster. On the occasion at Garvelloch the opportunity was afforded of examining a large number of lobsters as they were taken out of the creels.

Heller (8) records the species from the Adriatic.

Chatin (3) mentions a species, *Isaea nicea*, Thor: he says it is found abundantly at Port de la Joilette. Della Valle, however, states that this species remains undetermined.

The general resemblance of *Isaea montagui* to *Gammarus* is admitted by Milne-Edwards. He says: "In the genus *Isaea* the general form of the body is the same as in the Crevettes [*Gammarus*]. The superior antenna also ends in two segmented appendages, but in place of having the first two pairs of feet prehensile, these crustaceans have all the feet terminated by a movable claw, which folds upon the edge of the preceding segment." One may therefore ask why this form was not included in *Gammarus*. Edwards disregards the strong link with *Gammarus*, afforded by the general resemblance, etc.: he considered that in the matter of generic discrimination the character of the dactyls is the more important. Whether or not it is preferable to separate *Isaea* from *Gammarus* is a question upon which there is room for difference of opinion. There is no guiding rule other than the predilection or caprice of the author. That being so, it is apparent that the generic name is, from its instability, not a suitable name for the animal at all.

What are the principles upon which classification is founded? So far as I know they are not explicitly laid down. One may, however, discuss certain of the objects which the classification is intended to serve, and how far it succeeds in doing so.

Every animal requires a name, whereby it may be catalogued—only one name, the specific name, is necessary: by it the species is sufficiently labelled. But one cannot memorise all the specific names,

and therefore, in order that one may be assisted to understand the general form of the animal, a descriptive name is added. Now, in order that this name be of any use, it must be known by the general zoologist. That necessarily limits the descriptive names which can be usefully employed to a comparatively small number, *i.e.*, the number that can be memorised within a reasonable time.

The descriptive names in present use, *i.e.*, the generic names, are far too numerous to be the best suited for naming the species. No individual can remember them all. That, it must be admitted, is a disadvantage. If its signification be unknown, the generic name is so little better than the specific name used by itself, that it might as well be absent. The specialist, when he names an animal, hides its systematic position : he, as it were, kicks away the ladder by which he climbed.

I shall show that, in order to attain the principal objects of classification (which are (1), given the name of the animal to find the description, and (2), given the animal to find out the name which has been attached to it), the sub-division of the animal kingdom does not require to be carried out on a scale beyond that which makes Amphipoda a descriptive name.

If the species here dealt with had been named *Amphipoda montagui*, all zoologists would have known something about it, whereas under Edwards' name, *Isaea montagui*, it is altogether unknown to ninety-nine out of one hundred zoologists.

Amphipoda montagui would serve perfectly well for the two diagnoses mentioned above. In the first case one has simply to consult the index, and in the second the figures of the book on *Amphipoda*. Whereas if the form be known as *Isaea*, one has first to discover to what group the genus belongs. One has to get back to *Amphipoda*, and one might as well start with that name. In the second form of diagnosis it would not matter whether *Amphipoda* or *Isaea* were the descriptive name; the animal tells it own systematic position. But *Isaea* offers no advantage over *Amphipoda*. No name is required to intervene between *Amphipoda* and the specific name.

What, then, is the genus name, and what part does it play in a scheme of classification in, for example, Bate and Westwood's British Sessile-eyed Crustacea?

In order to demonstrate the status of the genus it is convenient to arrange a selection of the species under the descriptive name, *Amphipoda*. The genus is a product of later formation than the species, and should appear in the scheme of classification after, not before, the species.

Amphipoda	locusta	*Talitrus*, Latreille.	Orchestiidae	Vagantia
"	littorea, mediterranea, etc.	*Orchestia*, Leach.		
"	nilssonii, imbricatus	*Allorchestes*, Dana.		
"	lubbockiana	*Nicea*, Nicolet.		
"	monoculodes, marina, etc.	*Montagua*, Bate.	Gammaridae	
"	dubia	*Danaia*, Bate.		
"	costae, andouiniana, etc.	*Lysianassa*, Edwards.		
"	longicornis, edwardsi, etc.	*Anonyx*, Kröyer.		
"	crenata	*Callisoma*, Costa.		
"	gaimardii, belliana	*Ampelisca*, Kröyer.		
"	simplex, holbolli, etc.	*Phoxus*, Kröyer.		
"	imbricata	*Grayia*, Bate.		
"	caecula, hyalina	*Westwoodilla*, Bate.		
"	parvimanus	*Oediceros*, Kröyer.		
"	carinatus, stimpsoni	*Monoculodes*, Stimpson.		
"	arenaria, altamarina	*Kroyera*, Bate.		
"	manudens	*Amphilochus*, Bate.		
"	compressa	*Darwinia*, Bate.		
"	arenarius	*Sulcator*, Bate.		
"	bairdii, marinus, etc.	*Urothoe*, Dana.		
"	pallida, shetlandica	*Liljeborgia*, Bate.		
"	antiqua, kinahani	*Phaedra*, Bate.		

Although the specific names linked to the name *Amphipoda* are all that one requires for diagnosis, the authors have bracketted the species together in little lots (genera), to which they have assigned names.

The genera are then bracketted into families, and so on. This process is a kind of metaphysic, and should occupy the position of an appendix in a systematic work. It may sometimes be convenient to refer to the lot of species which Dana grouped under the name *Allorchestes*, or to those which Bate brought together under the name *Liljeborgia*; and it is possible that where diagnosis has to be carried out with the help of a work which has no figures, the generic, family, etc., descriptions may be of some assistance. I think, however, that in the latter case a simpler and more efficient key could in some cases be drawn up. A systematic work without figures cannot, however, be regarded as complete.

The basis upon which an author groups the species may be first morphological, and later physiological: his groupings are, however, ephemeral; they are binding on no other zoologist, and least of all on one who may later on study the different species more minutely.

Agreement might be secured to fix the generic names to animals on a supposed permanent basis. The Zoological Congress, indeed, proposes to fetter Zoology to a system of classification, which, although it is a creditable monument to the labours of the pioneers, is, in the present stage of zoological progress, insufficient. The only test for a scheme of classification is utility, not the *fiat* of any Congress. The classification that "lasts for aye" does not concern the present generation.

Zoology is afflicted with a surfeit of generic, morphological, and other terms which are multiplied out of all reason: it tends to become a study of names as much as a study of species.

It is evident that generic names, from their instability, and because their very number precludes one remembering their intentions, are unsuited for use as descriptive names. The latter ought to be established in a region that is stable, and that may be found in the group name. Such a selection would reduce the number of descriptive names to such as could be readily memorised.

Every department of Zoology should be readily accessible to all, and it would be so were the appellation of the animal formed on lines such as those to which attention has been directed.

LITERATURE CONSULTED.

1. BATE, C. S.—Catalogue of the Amphipoda in the British Museum. London, 1862.

2. BATE, C. S., AND WESTWOOD, J. O.—British Sessile-eyed Crustacea. London, 1863.

3. CHATIN, J.—Recherches pour servir à l'histoire du batonet optique chez les Crustacés et les vers. Ann. des Sci. Nat. (6), Zoologie, v, 1877, and vii, 1878.

4. CHEVREUX, E.—Catalogues des Crustacés Amphipodes marins du sud-ouest de la Bretagne, suivi d'un aperçu de la distribution géographique des Amphipodes sur les côtes de France. Bull. de la Soc. Zool. France, 1887. Paris.

5. DANA, J. D.—U.S. Exploring Expedition, Crustacea, vol. xiii, 1853.

6. EDWARDS, H. MILNE-.—Extrait de Recherches pour servir à l'histoire naturelle des Crustacés amphipodes. Ann. des Sci. Nat., xx. Paris, 1830.

7. ——— Histoire Naturelle des Crustacés, 4 vols.

8. HELLER, C.—Beiträge zur näheren Kenntniss der Amphipoden des Adriatischen Meeres. Plates. Denkschr. d. k. Akad. d. Wiss. Math.-Natur., Wien, xxvi, 1867.

9. ORTMANN, A. E.—Die Klassen u. Ordnungen der Arthropoden. V. II Abtheil. Crustacea. Das Tierreich, Leipzig, 1901.

10. STEBBING, T. R. R.—Amphipoda Gammaridea. Das Tierreich, Berlin, 1906.

11. VALLE, DELLA. Gammarini del Golfo di Napoli. Fauna u. Flora, Neapel, 1913.

SOME REMARKS UPON THE STRUCTURE AND GENERIC POSITION OF *IDOTEA LACUSTRIS*, THOMSON.

By WALTER E. COLLINGE, D.Sc., F.L.S.,

Research Fellow of the University of St. Andrews, The Gatty Marine Laboratory, St. Andrews.

WITH PLATE VI.

In my studies on the Valviferous Isopoda, the species described by G. M. Thomson in 1879,[1] under the name of *Idotea lacustris*, has long puzzled me. In the past I have known it only from the original description, and the two figures given by Miers.[2] The species figured by Miers is clearly not referable to the genus *Idotea*, Fabr., the general form of the body indicating its relationship to the genus *Pentidotea* of Richardson, and as such it has remained, with a query, on my card catalogue for some time past.

Recently, Professor Chas. Chilton has very kindly sent me examples of Thomson's species, from both a freshwater and a marine locality, and upon examining the oral appendages I find that my surmise as to its relationship to *Pentidotea* is quite correct, for instead of the palp of the maxillipede being composed of four joints, as in all members of the genus *Idotea*, it possesses five distinct joints.

In transferring it to this newer genus I have deemed it advisable to re-describe and figure the species in somewhat greater detail than has hitherto been done, and to reconsider the position of the species from Port Henry, Straits of Magellan, referred "with much hesitation" by Miers to *Idotea lacustris*, Thomson.

I have pleasure in here acknowledging Professor Chilton's kindness in furnishing me with the material upon which this work has been done, as well as other New Zealand species of Idoteidae.

---

[1] Trans. New Zealand Inst., 1879, vol. xi, p. 250.

[2] Journ. Linn. Soc. Lond., 1881, vol. xvi, pl. i, f. 11 and 12.

Pentidotea lacustris (Thomson).

Pl. VI, figs. 1-12.

Idotea lacustris, G. M. Thomson. Trans. New Zealand Inst., 1879, xi, p. 250.—Thomson and Chilton. Ibid., 1886, xviii, p. 156.—Chilton. Ibid., 1889, xxii, p. 194.

(?) *Idotea lacustris*, Miers. Journ. Linn. Soc. Lond., 1881, xvi, p. 39, pl. i, f. 11 and 12.

Body narrow elliptical, fairly convex, surface finely punctured. Cephalon (fig. 1) wider than long, with deep median indentation on the anterior margin, lateral lobes not very prominent; in front of the posterior margin is a well-marked transverse furrow. Eyes rather large, situated dorso-laterally, slightly posterior to the middle of the lateral lobe of the cephalon. Antennulae (fig. 2) reaching nearly to the end of the third peduncular joint of the antennae; composed of four joints, the first is broad and globose, the second and third narrower and sub-equal; flagellum rather longer with setae on the dorsal side and terminally. Antennae (figs. 3 and 4) when retracted extend to the posterior margin of the second segment of the mesosome, first four joints short, fifth joint longer and narrower; flagellum as long as the peduncle, with ten or eleven joints and a short terminal style. In the male there is a dense fringe of very fine setae. First maxillae (fig. 5) with the outer lobe terminating in five stout curved spines and six inner, more slender, denticulate ones; inner lobe with three setose spines and a single setule on the distal outer border. Maxillipedes (fig. 6) elongated, palp 5-jointed, basal plate narrow, epipodite conical, twice as wide as the basal plate, inner distal lobe short and wide, with numerous setose spines. The segments of the mesosome are almost sub-equal, excepting the first, which is slightly longer, with short close marginal setae; pleural plates of the first segment expanded, flanking the cephalon, rounded anteriorly, and bluntly pointed posteriorly. Coxal plates (fig. 7) occupying the whole of the lateral margins of segments 2—7, almost rectangular, those of segments 2—4 extending to the postero-lateral angles of the segments, those of segments 5—7 slightly wider, with the postero-lateral angles produced backwardly. Thoracic appendages (figs. 8 and 9) 2—5 rather short and directed forwards, 6—8 longer and directed backwards. The third appendage of the thorax, in the male, has a dense fringe of fine setae. Metasome (fig. 10) composed of two short segments, and the large terminal one, at the base of the latter, is a single suture on each side, indicating a further coalesced segment. Lateral margins of terminal segment entire and gradually narrowing to a bluntly rounded extremity, whole of margin with short close setae. Uropoda

(figs. 11 and 12) strongly convex, inner margin of basal plate straight, with small spine near the posterior end, rounded anteriorly and on the outer margin; endopodite somewhat triangular, with eleven or twelve fine spines on the inner terminal margin, which is finely crenulate, setose style long.

Length 15 mm. Colour (in alcohol) yellowish-brown, with fine irregular darker markings.

Habitat.—Freshwater stream, Mt. Mihiwaka, Otago, and Dunedin Harbour, New Zealand (C. Chilton).

This interesting species is widely separated from any other member of the genus. In the general outline of the body it approaches somewhat to the condition found in *P. wosnesenskii* (Brandt). In the shape of the cephalon and position of the eyes it is at once seen to differ from the members of the genus *Idotea*, Fabr.

The oral appendages have not hitherto been described or figured. The first maxilla has on the outer lobe terminally five stout curved spines on the outer side, and six more slender ones on the inner side, these latter are denticulate; the inner lobe has three long setose spines and a small setule on the distal outer border. The second maxillae are typical of the family. The maxillipedes are elongated, and the narrow basal plate has a 5-jointed palp, the epipodite is cone-shaped, and the inner distal lobe short and wide, with a number of setose spines terminally.

Professor Chilton[1] points out that "the 'dense fringe of short setae' on the antennae is found in the male only. There is no fringe on those specimens (nine in number) which I know to be females, whilst it is present in all the specimens (thirteen in number) which I know from other reasons to be males. In all of these it is associated with a similar fringe on the second pair of thoracic legs. In some specimens the frings is not so well developed as in others, and it seems to be developed first on the antennae and then on the second pair of legs, for in one or two specimens where there is only a slight indication of it on the antennae there is none at all on the second pair of legs. In all probability these fringes are a secondary sexual character, not developed in the males till they are mature, or perhaps developed only during the breeding season."

In the specimens forwarded by Prof. Chilton the fringe of the setae is not present on any of the males from Mt. Mihiwaka, Otago, and on only one of those from Dunedin Harbour. I agree with Chilton that it is probably developed seasonally or as a secondary sexual character of the mature males. Something allied occurs in *Idotea pelagica*,

[1] Trans. and Proc. New Zealand Inst., 1889, vol. xxii, p. 194.

Leach, where, on the inside of the thoracic appendages, the male occasionally has a dense fringe of fine setae. Sars[1] gives this as one of the specific characters of the male, but I have examined large numbers where it was not present; like the above case it may possibly only be developed during the breeding season.

Both Thomson (*op. cit.*) and Chilton (*op. cit.*) state that there are two lateral sutures on the terminal segment of the metasome, the latter author remarking "the 'posterior' suture extending further to the centre than the anterior." In the specimens I have examined from the freshwater locality there is a single suture only, and in the marine specimens this is partly sub-divided. The terminal margins of the uropoda are finely crenulated, with eleven or twelve fine spines, whilst towards the base of the inner margin of the basal plate there is a small spine with a collar-like margin.

Respecting the specimens referred by Miers to *I. lacustris*, judging from his two figures, I doubt very much if they belong to this species. The shape of the cephalon and coxal plates are certainly different, and there are minor differences in the form of the uropoda.

Miers (*op. cit.*, p. 40) states: "The figure is from specimens in the British Museum collection from Port Henry, Straits of Magellan (Dr. R. P. Coppinger), that agree fairly well with the above description, but which I refer with much hesitation to *I. lacustris*, on account of the widely remote locality. I at first (Proc. Zool. Soc., 1881, p. 76) referred them with doubt to *I. annulata*, Dana, a species that in this revision is regarded as synonymous with *I. metallica*. The colour in these specimens is of a uniform chestnut-brown, the front margin of the head very slightly excavated, and the flagella of the antennae 7-jointed. If distinct they may be designated *I. rotundicauda*."

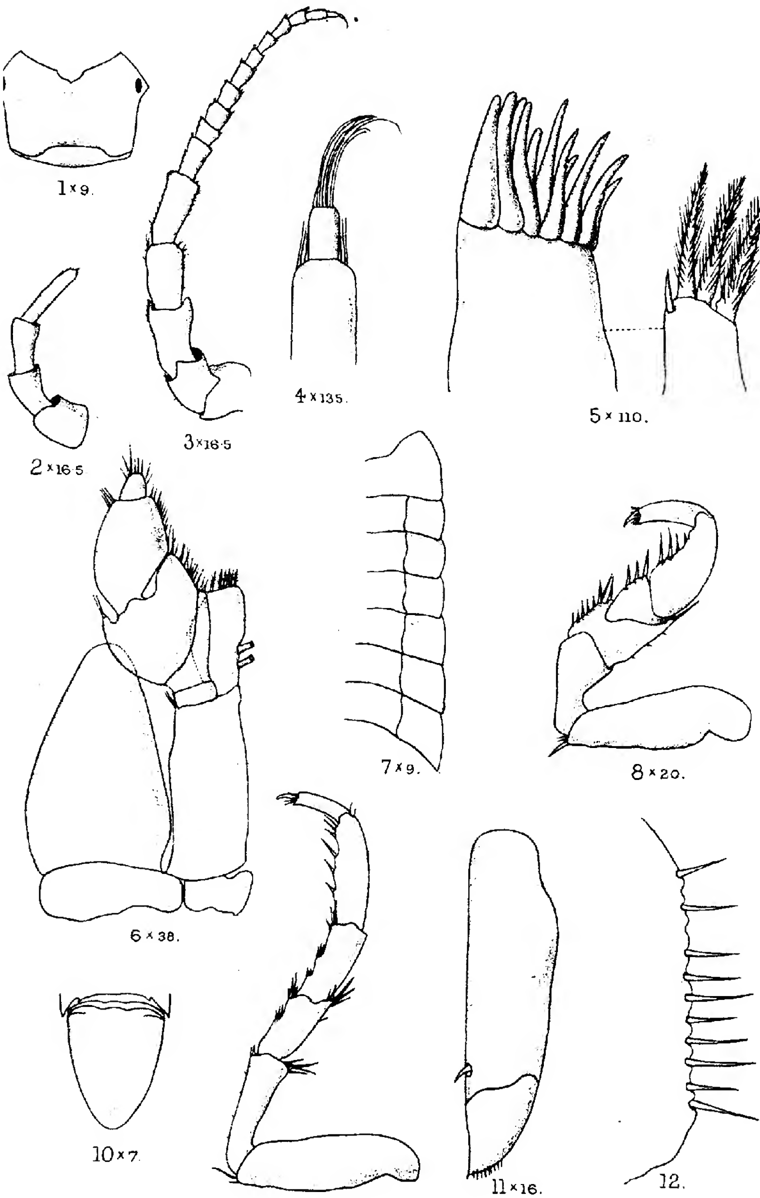
I have not yet had the opportunity of examining these specimens, but at present I am inclined to regard them as distinct from Thomson's *I. lacustris*.

The genus *Pentidotea*, to which *Idotea lacustris*, Thomson, is now referred was founded by Richardson[2] in 1904, and described as follows:—

"Flagellum of second antennae multi-articulate. Maxillipedes with a palp composed of five articles. Epimera of all the segments of the thorax, with the exception of the first, distinctly separated from the segments. Abdomen composed of three segments, with a suture

[1] Crust. Norway, 1899. vol. ii. p. 82, pl. xxxiii.

[2] Bull. No. 54 U.S. Nat. Mus., 1905, p. 368.



ı. K. del. ad nat. Huth, London.

PENTIDOTEA LACUSTRIS (Thomson).

line on either side of the terminal segment at the base, indicating another partly coalesced segment."

The four species hitherto known belonging to this genus are the *Idotea resecata*, Stimpson, *I. wosnesenskii*, Brandt, *I. whitei*, Stimpson, and *I. stenops*, Benedict.[1]

Whilst many of the Idoteidae possess a 5-jointed palp of the maxillipede, none, excepting *Pentidotea*, agree in combining with this character a metasome with only three segments, and only two other genera of the family possess this latter character, viz., *Chiriscus*, Richardson, in which the palp of the maxillipede is described as consisting of three joints, and the genus *Idotea*, Fabricius, where there is a four-jointed palp.

Hitherto the genus *Pentidotea* has been known from the Northern Pacific only.

EXPLANATION OF PLATE VI,

Illustrating Dr. Walter E. Collinge's paper on "Some Remarks upon the Structure and Generic Position of *Idotea lacustris*, Thomson."

Pentidotea lacustris (Thomson).

Fig. 1. Dorsal view of the cephalon. × 9.
Fig. 2. Dorsal view of the right antennule. × 16.5.
Fig. 3. Dorsal view of the right antenna. × 16.5.
Fig. 4. Terminal style of the antenna. × 135.
Fig. 5. Ventral side of the terminal portions of the inner and outer lobes of the right 1st maxilla. × 110.
Fig. 6. Ventral side of the right maxillipede. × 38.
Fig. 7. Dorsal view of the lateral portions of the mesosomatic segments, showing the coxal plates. × 9.
Fig. 8. Ventral view of the 2nd thoracic appendage. × 20.
Fig. 9. Ventral view of the 8th thoracic appendage. × 20.
Fig. 10. Dorsal view of the metasome. × 7.
Fig. 11. Left uropod. × 16.
Fig. 12. Spinous setae from the distal border of the uropod.

The author desires to thank the Carnegie Trust for the Universities of Scotland for a grant to defray artists' charges.

---

[1] Miers (*op. cit.*, p. 42) referred two males in the Paris Museum collection received from California to *I. whitei*, Stimpson, which are probably correctly named, but he states that "it is possible that the examination of a larger series would demonstrate the necessity of uniting this species with Brandt's *I. wosnesenskii*." I have examined specimens of both of these species and regard them as perfectly distinct.

A NOTE ON THE VARIATION OF THE PSEUDO-TRACHEAEL BEARING APPENDAGES IN SOME TERRESTRIAL ISOPODA.

By WALTER E. COLLINGE, D.Sc., F.L.S.,
Research Fellow of the University of St. Andrews.

In examining the abdominal appendages of various species of British and foreign terrestrial Isopoda, I have frequently noted the tendency of these organs to vary in shape and size in different examples of the same species, and this led me quite recently to remark upon their unsatisfactory nature for purposes of generic or specific distinction.[1]

Fortunately few writers have employed them for such purposes, but in not a few of the descriptions of certain species particular weight has been attached to the number of the abdominal appendages bearing pseudo-tracheae.

As is well known these appendages in the sub-order Oniscoida are plate-like in structure, with the exception of the sixth. Each consists of an inner plate, the endopodite, which functions as a branchial organ, and an outer plate, the exopodite, which covers and protects the former.

In some genera, *e.g.*, *Porcellio*, Latr., *Porcellionides*, Miers, *Cylisticus*, Schnitzler, *Armadillidium*, Brandt, and *Eluma*, B.-L., air-tubes or pseudo-tracheae are present in the outer plate on the first and second appendages, and sometimes on the three succeeding ones as well.

Sars[2] states: "In some cases this opercular plate [the exopodite] contains on the two anterior pairs, more rarely on all the pairs, air-cavities or pseudo-tracheae" (p. 154). He further states that in *Ligidium*, Br., they are "very thin, without any obvious branchial structure" (p. 157); also in *Trichoniscus*, Br.; "without any air-cavities" in *Oniscus*, L., and *Platyarthrus*, Br. He further remarks upon their presence in *Porcellio*, Latr., *Porcellionides*, Miers, *Cylisticus*, Schnitz., and *Armadillidium*, Br., mentioning the number present in each species.

Calman[3] remarks "the exopodites of the first and second, and

---

[1] Ann. Natal Mus., 1916, vol. 3, p. 577.

[2] Crust. of Norway, 1898, vol. ii.

[3] Lankester's Treatise on Zoology, Pt. vii, fas. 3. Crustacea, 1909, p. 205.

sometimes of all five, pairs are specially adapted for aerial respiration by the development within them of small cavities opening to the exterior by slit-like apertures, and giving rise internally to a system of ramifying tubules filled with air. . . . In certain cases (*Oniscus*) in which the pseudo-tracheae are absent, their place is taken by a system of air-filled spaces, immediately under the cuticle of the exopodite. These spaces do not communicate with the exterior, and appear to become filled with air by diffusion through the cuticle."

Amongst our British species practically all writers give the following as the number of appendages bearing these structures :—

Porcellio scaber, Latr., *P. pictus*, Br., *P. dilatatus*, Br., *P. laevis*, Br., *Porcellionides pruinosus*, Br., all species of *Armadillidium*, Br., and *Eluma purpurascens*, B.-L., in the first two appendages.

Porcellio rathkei, Br., *P. ratzeburgii*, Br., and *Cylisticus convexus*, De Geer, in the appendages 1 to 5.

Some little time back I had submitted to me a specimen of *Porcellio* in which the pseudo-tracheae were present in the appendages 1 to 5, in consequence of which it was thought to be referable either to *P. rathkei* or *P. ratzeburgii*; a careful examination of the specimen, however, showed that it belonged to neither of these species, but was in every other feature a typical example of *P. pictus*.

The above discovery led me to examine a large number of specimens of *P. pictus* from various localities, and I found considerable variation, thus in two specimens there were pseudo-tracheae in all five appendages, in another they were present in appendages 1 to 3, and seventeen others they were present in the first two appendages only.

In another lot of twenty, four specimens had these structures in appendages 1 to 3, and two in appendages 1 to 4.

In *P. rathkei* and *Armadillidium vulgare*, Latr., similar variations occurred.

Time has not permitted of my examining any further species, but it would be very interesting if someone would submit all the British species to a careful examination, as at present it is very doubtful if these structures are at all constant, and in which particular species they occur.

REVIEWS.

EARLIEST MAN. By F. W. H. Migeod. Pp. xii + 133. London: Kegan Paul, Trench, Trübner & Co., Ltd., 1916. Price 3s. 6d. net.

In this interesting and suggestive little book Mr. Migeod has endeavoured to give a sketch of the cultural evolution of man from his simian condition up to the time that he attained distinctly human rank. From the nature of the case the book is all guess-work, the author, however, bases his guesses on his observations on the habits of animals and backward man, and by employing a commonsense logic gives a general air of probability to his argument—all one can say is that if it did not happen in this wise, it might very well have done so.

The author seems to minimise the extent to which the ape-man and the higher apes were carnivorous, and thereby draws a too sharp distinction between what he terms the vegetarian and carnivorous phases in the evolution of man, possibly he makes early Homo too carnivorous.

Mr. Migeod appears to have paid insufficient attention to the possibility of forerunners of man being truly gregarious. It may be that their relative physical weakness and social habits were among the main factors in their ascent to humanity; we may also regard pack law as the origin of ethics. Surely by pantheism (pp. 118, 119) the author means polytheism.

Any hypothetical descent of man must be open to criticism, and that given by the author is no exception. It is disputable whether *Pithecanthropus erectus* is in the direct line of evolution. *Homo primigenius* does duty for *H. heidelbergensis*, Neanderthal man, *Eoanthropus dawsoni* (whatever that may prove to be), and a hypothetical Asiatic form. The latter is supposed to have given rise to the *Aurignacian* race (*H. sapiens*), from which is derived the Negro in part (and in part from Neanderthal man) and all the other races of man. The Negro, Negrito, and Bushman and African Pygmy are represented as being on three distinct lines of descent, the Bushman-Pygmy group being on the same line of descent as Caucasians, etc. The whole arrangement seems confused, and separates those types which are generally recognised as being allied. The cautionary footnote does not help matters very much. This scheme suggests that the author would be better described as a naturalist rather than as a zoologist.

As Mr. Migeod has written grammars of the Mende and Hausa languages, and has published a great linguistic survey of West African

languages; doubtless he has made use of his linguistic attainments to study the psychology of West African natives. May it be permitted to suggest to him that he should endeavour to interpret this for the benefit of local residents and students at home. A work of this kind could not fail to prove of great value.

A. C. Haddon.

Form and Function: A Contribution to the History of Animal Morphology. By E. S. Russell. Pp. ix + 383 and 15 figs. London: John Murray, 1916. Price 10/6 net.

No one seriously interested in the great problems of morphology can afford to overlook this important book, which traces the history of the study of organic form from Cuvier and St. Hilaire to Huxley and Roux. We have read the bulk of the modern contributions to the history of Biology, but, apart from a few isolated essays, we have seen nothing so finely finished, so scholarly, so well-balanced, as "Form and Function." Mr. Russell has for many years given the leisure hours of a busy life to making himself at home among the original documents, and his readers reap the reward of his patient and sympathetic study. For our author has thought himself thoroughly into the point of view of men like Cuvier, Etienne Geoffroy St. Hilaire, Buffon, Lamarck, von Baer, Owen, and the result is proportionately convincing and valuable. There is no doubt that the study of Biology in Britain has handicapped itself by a neglect of historical discipline—a neglect which leads to the gratuitous repetition of errors and confusions. This book offers a way out, for it supplies carefully selected quotations from the works of the great masters, and it gives an appreciation of the significance of the contribution which each made. It is trustworthy, impartial, and vividly clear. Mr. Russell is a graduate of Glasgow University, the author of a number of faunistic and œcological studies, and of some remarkable essays and critiques in the international Journal "Scientia." His present work does great credit to the school in which he was trained as well as to his own abilities. It is to be hoped that he will find opportunity to follow up the historico-philosophical studies of this volume with a full statement of his own position as an evolutionist.

It is difficult to single out chapters where all is excellent, but we have been especially impressed with the way in which the author has dealt with the famous controversy between Cuvier and Etienne Geoffroy St. Hilaire, the work of von Baer, the influence of the Cell-Theory, the development of the Recapitulation Doctrine, and the significance of more recent workers like Gegenbaur and Roux. Many will be glad to see that the author takes Samuel Butler seriously, and recognises the importance of his genius.

Underlying much of the book, and continually cropping up, is the far-reaching question whether function determines form, or form function. Is function an output of preformed organisation, or is organisation due to the imprinting and enregistering of the results of

function? Mr. Russell. does not conceal his sympathies, for he evidently sides with the "functional" school of Cuvier and von Baer rather than with the "formal" school of St. Hilaire and Owen. One closes the fascinating book, however, with the conviction that in the light of increased knowledge the old antithesis has lost its stringency, and that the position to be made clear is one which recognises the elements of truth on both sides. We offer Mr. Russell our sincere congratulations on the accomplishment of what is indeed a *magnum opus*.

J. ARTHUR THOMSON.

THE MIGRATIONS OF FISH. By Alexander Meek. Pp. xvii + 427, 12 pls. and 128 text-figs. London: Edward Arnold, 1916. Price 16s. net.

Scientific research into the natural history of marine and fresh-water fishes has been forced upon the State rather than undertaken voluntarily by the latter. For a century or more a legislative code of some kind, prescribing the seasons during which fish might legally be caught, and the manner of their capture, has been adopted in most maritime countries. Looking back upon these codes, one finds it difficult to imagine what were the reasons that led up to the many futile or harmful regulations of the past. About the middle of the nineteenth century the necessity for scientific investigation was first thoroughly realised, and with the formation of the Scottish Fishery Board in 1882, and the work of the Trawling Commission of 1885, research was actively prosecuted. Since then very much has been done.

Yet it is doubtful whether enough is known to enable anyone to present an adequate account even of the facts of fish migrations, much less the natural factors governing these movements. A complete knowledge of the life-histories of the animals, as well as a knowledge of the physical changes in the sea—annual temperature and salinity changes, currents and their seasonal variations, etc.—would be necessary, and the knowledge that we possess with regard to these matters is still very incomplete. But, making all allowance for this inadequacy and data, it was still a desirable thing that someone should put together what the research of the last two decades in particular has elicited.

Prof. Meek's book is a general survey of the whole group of fishes, even of fossil forms, from the point of view of their distribution and movements in space and time, and it is the best summary of the geographical distribution of the group that has yet been attempted. Comparatively little is said as to the migrations of most of the species mentioned, since these, having little economic importance, have not been investigated. But some fishes, the Salmon and other allied forms, the Herring, Pilchard, Sprat and Anchovy, the Eels, flat fishes such as the Plaice and Sole, Gadoid fishes such as the Cod, Whiting and Halibut, have all received much study, so that at least a provisional account of their life-histories and seasonal migrations can now be compiled. This is the merit of Prof. Meek's book. He puts together

the main facts contained in a multitude of memoirs, and provides a useful starting-off ground for investigators imperfectly acquainted with the literature of this branch of marine zoology.

General principles are naturally difficult to formulate with respect to a subject the methods of which are still incompletely evolved. One feels that so much still remains to be learned as to the causes of migratory movements of fishes and other animals as to render any attempt at their presentation only a tentative one. Periodic and secular changes in the temperature and salinity of the water of the sea; variations in the direction and intensity of oceanic currents; tides; changes in the relative distribution of land and sea; even cosmic events, such as the variations of solar radiation: all these are factors influencing fish migrations, and their mode of action and relative importance are still matters for further investigation. They are duly considered in Prof. Meek's work.

The book is well printed and unsparingly illustrated, and the index is very full. Bibliographical references might have been even more numerous than they are in a book which will be consulted by all workers in economic marine biology.

J. JOHNSTONE.

GLI AGAONINI (*Hymenoptera, Chalcididae*) raccolti nell 'Africa Occidentale dal Prof. F. Silvestri. By G. Grandi. Boll. del Lab. Zool. gen. e agraria della R. Scuola super. in Portici. 1916, vol. x, pp. 121-286 and 52 text-figs.

This important memoir deals with seven genera comprising twenty-two species of Agaonidae, which is one of the most remarkable families of the Chalcidoidea. It has long been a problematical assemblance of Hymenoptera on account of the curious habits, diversity of form, and sexual dimorphism exhibited among the various species. Ashmead limited the family to those forms which are caprifiers or true fig-insects, that live in, and are believed to pollenize fig-trees. Wherever fig-trees flourish in warm and tropical countries these insects abound, and in all probability the greater number of genera and species still remain to be discovered. Certain inquilines and true parasites are placed by Ashmead in the Torymidae, while a few pertain to other Chalcid families.

In the present work one genus, *Allotriozoon*, with two new species, are described for the first time. Eighteen species distributed among the genera *Blastophaga*, *Ceratosolen*, *Sycophaga*, *Crossogaster*, and *Apocrypta* are also described as new. The descriptions are models of careful, detailed study, and reflect great credit on the Italian school of systematists. In many cases both the males and females have been discovered, and their structural details are well illustrated. Included in the memoir is a useful key to the identification of both sexes of the known species of *Blastophaga*, and there is also a long and detailed study of *Agaon paradoxum*, Dalm., which has hitherto been imperfectly known. A work of this nature affords a striking contrast to many

recent systematic papers, wherein new species and genera are often hastily and inadequately described.

A. D. IMMS.

THE LIFE OF INLAND WATERS. An elementary text-book of freshwater biology for American students. By James G. Needham and J. T. Lloyd. Pp. 438 and 244 text-figs. Ithaca, N.Y.: The Comstock Publishing Co. 1916. Price $3.

Few writers are better qualified to undertake the preparation of a work on freshwater biology than the authors of this fascinating text-book. Freshwater biological stations have long flourished in the United States, and much valuable work has emanated from them, to which Professor Needham and his colleague have contributed in no small degree. The work before us, therefore, although only an elementary one, comes from the hands of experts of wide experience and more than fulfils our expectations.

Briefly, its scope is as follows:—An opening chapter introduces us to the science of limnology or the study of freshwater biology, and the various agencies in the United States that furnish aid and support to investigations in this subject. The physical and chemical conditions of water are next discussed, followed by a chapter on the types of aquatic environment, *e.g.*, lakes, ponds, streams, marshes, swamps, bogs, etc. An excellent survey of aquatic organisms next illustrates the wonderful fauna and flora of freshwater areas, and interesting as this is, it is eclipsed by the two further chapters treating of the adjustment of animals and plants to the varying conditions of aquatic life. These two chapters are full of excellent matter, set forth in a vivid manner that cannot fail to interest and arrest the attention of the reader.

It is obviously beyond the limits of this review to remark upon the various examples given and the numerous problems arising therefrom, suffice it to say that together they form one of the most pleasing and fascinating accounts of elementary biology we know of; indeed, the subject matter throughout is striking in its lucidity and mode of presentation.

The illustrations are all excellent and the typography wonderfully clear. There is a useful bibliography and a copious index.

We congratulate the authors on the production of a work that is wonderfully fresh and stimulating, and one that will be read with appreciation by a wide circle of students.

WALTER E. COLLINGE.

MONOGRAPH OF THE LAND AND FRESHWATER MOLLUSCA OF THE BRITISH ISLES. By John W. Taylor, Vol. iv, pt. 22, pp. 1-64, pls. i-v and 92 text-figs. Leeds: Taylor Bros. 1916. Price 7s. 6d.

The appearance of the first part of the fourth volume of this comprehensive work will be welcomed by conchologists both at home and abroad. Many exceedingly valuable works on the Mollusca have been

written by British conchologists, but no one has attempted to deal with either the marine or the land and freshwater, species in the detail, or with the wealth of illustration that characterizes Mr. Taylor's monograph, and it will long serve as a criterion for such works on other groups of our fauna.

The high standard reached in the three previous volumes is fully maintained; indeed, we think the coloured plate surpasses the high artistic level and scientific accuracy so conspicuous in past volumes. The same care and exactitude are dominant throughout, there is no slackening off, every detail receiving the same minute and careful attention.

The present part deals with the genera *Hygromia*, Risso, and *Helicodonta*, Fér., and treats of the following species :—*striolata* (C. Pfeiffer), *hispida* (Linn.), *revelata* (Michaud), *fusca* (Montagu), and *Helicodonta obvoluta* (Müll.). All of these are dealt with very fully, the anatomy, synonymy, variation, geological and geographical distribution being given in detail.

Thanks to the co-operation of Mr. W. Denison Roebuck, the record of the distribution grows more and more complete.

It is a monumental work destined to rank as a classic in the future, and it will ever prove of inestimable value to all interested in the molluscan fauna of the British Isles. Mr. Taylor is to be highly congratulated on the fruition of his life-long labours.

WALTER E. COLLINGE.

BIRDS IN RELATION TO THEIR PREY: Experiments on Wood-Hoopoes, Small Hornbills, and a Babbler. By C. F. M. Swynnerton. Journ. Sth. African Ornith. Union, 1915, pp. 32-108.

The series of experiments carried out by Mr. Swynnerton are of interest to the ornithologist and entomologist in particular and to zoologists generally. It is only possible here to direct attention to the chief points of interest.

The experiments were made with captive birds, which were fed chiefly with Lepidoptera and their larvae, but wasps, grasshoppers and other insects were also used. Amongst the Lepidoptera were protectively coloured, edible species, and the warningly coloured, nauseus species. The author finds that the most nauseus forms are readily eaten if the birds are hungry, even those birds with the smallest capacity for eating nauseus insects are able to eat one or two with apparent impunity, and even eagerness, when their stomachs are empty and appetite good. Thus the average bird may quite readily eat Danainae or Acraeinae several times in the day—in the early morning or after some other long interruption to feeding and after the ejection of each pellet. As the stomach fills up, the bird rejects such very low-grade prey, but eats other species, some of which, in turn, it finally rejects when slightly fuller, though still eating the others. And so, through the successive elimination of many grades, right up to repletion point.

The author is of opinion that discrimination between edible and

nauseating forms is acquired by experience only, and not instinctively. Some very interesting observations on parental education and personal experience would seem to give weight to this conclusion. We fully agree with the opinion that "The whole relations of old birds to young in the matter of food is a most interesting question for study," and, we would add, one that has been singularly neglected in the past.

From observations made on wild Bulbuls, the author concludes that the parent birds captured what they were hungry enough for, and if it was refused by the young (as it frequently was) it was eaten by the parent.

The paper is full of interesting facts set forth in great detail. We shall look forward with great interest to the author's further work, which we understand is in the Press.

WALTER E. COLLINGE.

THE ANIMAL PARASITES OF MAN. By H. B. Fantham, J. W. W. Stephens, and F. V. Theobald. Pp. xxxii + 900 and 423 text-figs. London: John Bale, Sons and Danielsson, Ltd., 1916. Price 45s. net.

Much of the recent work on the animal parasites of man has not hitherto been incorporated in any text-book, and so voluminous has this literature become that there is a pressing need for an up-to-date treatise which summarises it.

The work before us has, unfortunately, been partly founded upon Braun's *Die Tierischen Parasiten des Menschen*, and a supplement, numerous appendices, and innumerable foot-notes added, the result being that we have a really valuable amount of material jumbled together in a most heterogenous manner. The authors are quite capable of writing a new work, and many will regret that they have encumbered themselves with the skeleton of Braun's work, which has not been conducive to homogeneity or lucidity in the present production.

Dr. Fantham is responsible for the first section dealing with the Protozoa; this is practically new, little remaining of the original text. Dr. Stephens has remodelled, indeed almost rewritten, the section on Worms, and Professor Theobald has added a large amount of new matter to the section dealing with Arthropoda.

Whilst the authors have brought together a remarkable mass of very useful data, a less pretentious work, better edited, would, in our opinion, have proved much more useful.

WALTER E. COLLINGE.

INSECT ENEMIES. By C. A. Ealand. Pp. xiii + 223 and 53 figs. London: Grant Richards, Ltd. 1916. Price 6s. net.

At a time when economic entomology seems once again to have fallen into the background, it is well to be reminded that, in the words of the author of this little handbook, "all who have the national welfare at heart, should give more than passing thought to their six-legged

enemies." This work is certainly likely to arrest the attention of the agriculturist, horticulturist, and layman, for it enumerates the life-histories and depredations of a large number of injurious insects in a very pleasing manner, and within a small compass contains a surprising amount of sound information of those insects injurious to forestry, fruit trees, flower and vegetable gardens, farm crops, domestic animals, and man. All interested in any of these will find much that is profitable and practical, which is more than can be said for the majority of similar works on the subject.

There is a useful appendix dealing with the methods of using various insecticides, etc., a short bibliography, which might usefully have been extended, and a good index.

THE

JOURNAL

OF

ZOOLOGICAL RESEARCH.

COVENTRY:
Printed by Curtis and Beamish, Ltd.